Project Manual

Volume 1

FARMINGTON MUNICIPAL SCHOOLS

FARMINGTON PRESCHOOL ACADEMY

5840 FORTUNA DR. FARMINGTON, NM, 87402

March 21, 2024

PSFA PROJECT No: K23-001

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Division 21 –

Fire Suppression

SECTION 21 0500 - COMMON WORK REQUIREMENTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. See General Conditions and Supplemental General Conditions.

B. The requirements listed under General Conditions and Supplemental General Conditions and the General Requirements are applicable to this section and all subsequent sections of Division 21 and form a part of the contract.

C. Division 22 for Plumbing Systems.

D. Division 23 for Heating, Ventilating and Air Conditioning (HVAC) Systems.

E. Division 26 for Electrical Systems.

F. Division 28 for Fire Alarm Systems.

G. Division 31, for Trenching, Backfilling and Compaction requirements.

H. Division 33 for requirements of site utility systems, including sanitary sewer, storm sewer, domestic water distribution system, fire main water distribution system, and natural gas service.

I. All electrical work, regardless of voltage which is provided under Division 21 shall comply with the requirements of the National Electric Code (NEC) and Division 26.

1.2 FIRE SUPPRESSION DIVISION INDEX

A. Section 21 0500 Common Work Requirements for Fire Suppression

B. Section 21 0501 Demolition for Fire Suppression

C. Section 21 0503 Trenching and Backfilling for Fire Suppression

D. Section 21 0504 Pipe and Pipe Fittings for Fire Suppression

E. Section 21 0505 Piping Specialties for Fire Suppression

F. Section 21 0523 Valves for Fire Suppression

G. Section 21 0548 Vibration and Seismic Control for Fire Suppression

H. Section 21 0549 Fire Suppression and Electrical Installation Coordination

I. Section 21 1313 Fire Protection System, Automatic Wet Pipe Sprinkler

1.3 CODES AND PERMITS

A. The fire suppression shall be performed in strict accordance with the applicable provisions of the Uniform Building Code, 2009 Edition; the Uniform Plumbing Code, 2009 Edition; the Uniform Mechanical Code, 2009 Edition and the Uniform Fire Code, 2009 Edition as adopted and interpreted by the State of New Mexico, City of Farmington, and the National Fire Protection Association (NFPA Regulations), current adopted edition, regarding fire protection, heating and ventilating and air conditioning systems and electrical systems. All materials and labor necessary to comply with rules, regulations and ordinances shall be provided. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. The Contractor shall hold and save the Owners Representative free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

B. Permits necessary for performance of the work shall be secured and paid for by the Contractor. All utility connections, extensions, and tap fees shall be paid for by the Contractor, unless otherwise specified herein. See Division 33 for all requirements associated with utility permits and fees, connections and extensions.

C. The following lists some applicable codes and standards that shall be followed.

1. Applicable county and state mechanical, electrical, gas, plumbing, health and sanitary codes, laws and ordinances

2. National Electrical Manufacturer's Association Standards

3. National Electrical Code

4. Underwriters Laboratories, Inc. Standards

5. American National Standards Institute

6. American Society for Testing Materials Standards

7. Standards and requirements of local utility companies

8. National Fire Protection Association Standards

9. American Society of Mechanical Engineers Boiler and Pressure Vessel Codes

10. Occupational Safety and Health Act

11. The American Society of Sanitary Engineering

1.4 RECORD DRAWINGS

A. See Division 1, for requirements associated with Project Record Drawings.

B. The Contractor shall be responsible to maintain a complete and accurate set of marked up prints showing information on the installed location and arrangement of all mechanical work, and in particular, where changes were made during construction. The Contractor shall be responsible

for keeping record drawings accurate and up-to-date throughout the construction period. Record drawings may be reviewed and checked by the Owner's Representative during the construction and in conjunction with review and approval of monthly pay requests. The Contractor shall include copies of all addenda, RFI's, bulletins, and change orders neatly taped or attached to record drawing set.

C. After installation and acceptance of direct buried underground piping and service lines in trenches, the Contractor shall take 'as-built' measurements, including all depths, prior to commencement of backfilling operations. It will not be sufficient to check off line locations. Definite measurements shall be taken for each service line. The location of buried piping and trench service lines shall be shown on the drawings and dimensioned from fixed points.

1.5 QUALIFICATIONS

A. All mechanics shall be skilled in their respective trade.

B. All welders shall be certified in accordance with the ASME Boiler Test Code, Section IX, latest issue.

1.6 QUALIFICATION PROCEDURES

A. The storage, handling, and transportation of all refrigerants, oils, lubricants, etc. shall be accomplished in strict compliance with all State, local, and Federal Regulations including all requirements set forth by the Environmental Protection Agency (EPA) for the safe handling of regulated refrigerants and materials. The Contractor shall utilize qualified and/or certified personnel and equipment as prescribed by these requirements.

1.7 HAZARDOUS CONDITIONS

A. Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operation personnel, shall be cut back and/or protected to reduce the risk of injury.

1.8 HAZARD SIGNS

A. Equipment rooms, fan plenums, and similar areas containing moving or rotating parts, or other potentially hazardous environments shall include signs on all doors entering such spaces that shall read similar to the following: "Hazardous Area - Authorized Personnel Only."

B. Confined Spaces: Areas designated by OSHA Standard 1910.146 as a confined space shall be marked with a sign that reads "Confined Space - Entry by authorized personnel only, by permit."

1. "Confined Space" means a space that:

a. Is large enough and so configured that an employee can bodily enter and perform assigned work; and

b. Has limited or restricted means for entry or exit (for example, tanks, vessels, storage bins, hoppers, vaults, and pits are spaces that may have limited means of

entry); and

c. Is not designed for continuous employee occupancy.

C. The Contractor shall survey the final premises to determine where any such potentially hazardous areas exist. If the Contractor feels that hazards exist which cannot be suitably provided for through the above typical methods, he shall forward in writing his concerns, and request for a decision concerning the referenced hazard, prior to the final inspection of the facilities.

1.9 SUBMITTALS

A. The Contractor shall submit submittal brochures of all equipment, fixtures and materials to be furnished under Division 21, including but not limited to the following:

1. Piping materials, valves, equipment and installation methods, vibration isolation devices, pipe penetration installation methods and products for fire rated assemblies, fire pump systems, and all equipment listed on equipment schedules, and in related construction documents.

2. Materials, certification, shop drawings, and other information as specified in the individual Division 21 Specification Sections within this Specification.

B. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior review or are installed in a manner which is not in conformance with the requirement of this Specification and for which the Contractor has not received a written review, removal of all the unauthorized materials and installation of those indicated or specified shall be provided at no change in contract amount.

C. All equipment shall be installed in accordance with the manufacturer's recommendations. Provide all accessories and components for optimum operation as recommended by the manufacturer.

D. Expense: All costs for the preparation, correction, delivery, and return of the submittals shall be borne by the Contractor.

E. Submittals and one resubmittal will be reviewed by the Architect/Engineer. If the Contractor fails to provide the required data with his second submittal, he will be charged for the third and subsequent reviews.

F. See Division 1 for additional submission requirements.

G. The Contractor shall submit a maximum of seven (7) copies of submittal brochures for review. Brochures shall be submitted within thirty (30) days after contract award. One (1) copy of all submittal data will be retained by the Engineer and one (1) copy will be provided to the Owner's Representative. The remaining copies will be returned to the Architect. Additional sets of submittals, if required by the Contractor, shall be reproduced by the Contractor from the reviewed and marked sets returned to the Contractor.

H. Complete data must be furnished showing performance, quality and dimensions. No equipment or materials shall be purchased prior to receiving written notification that submittals have been

reviewed and marked either "NO EXCEPTIONS TAKEN" or "EXCEPTIONS AS NOTED." Submittals returned marked "EXCEPTIONS AS NOTED" do not require resubmittal provided that the Contractor agrees to comply with all exceptions noted in the submittal, and so states in a letter.

I. Review of Submittals: Submittals will be reviewed with reasonable promptness, but only for conformance with the design concept of the Project and for conformance with the information indicated on the Drawings and stated in the Specifications. Review of a separate item as such will not indicate review of the assembly in which the item functions. Review of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents, nor for errors or omissions in the submittals; or for the accuracy of dimensions and quantities, the adequacy of connections, and the proper and acceptable fitting, execution, functioning and completion of the work. Review shall not relieve the Contractor of responsibility for the equipment fitting within the allotted space shown on the drawings with all clearances required for equipment operation, service and maintenance including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC). Any relocation of mechanical and/or electrical equipment, materials and systems required to comply with minimum clearances shall be provided by the Contractor without additional cost under the Contract.

J. Shop drawings will be returned unchecked unless the following information is included: cover sheet shall be provided for each submittal of equipment, products and material proposed for use on the project. A common cover sheet for similar equipment (example: all air handling units or all fire protection products) is acceptable. The cover sheet shall list equipment by symbol number; reference all pertinent data in the Specifications or on the drawings; provide size and characteristics of the equipment, name of the project and a space large enough to accept a review stamp. The data submitted shall reflect the actual equipment performance under the specified conditions and shall not be a copy of the scheduled data on the drawings. Cover sheet shall clearly identify any deviations from the specifications for submitted equipment, products, and materials.

K. Use of substitutions reviewed and checked by the Engineer does not relieve the Contractor from compliance with the Contract Documents. Contractor shall bear all extra expense resulting from the use of any substitutions where substitutions affect adjoining or related work required in this Division or other Divisions of this Specification.

L. If Contractor substitutes equipment for that drawn to scale on the drawings, he shall prepare a 1/4" = 1'-0" installation drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, and including piping, and electrical equipment requirements, to verify that equipment will fit space with adequate clearances for maintenance. This 1/4" = 1'-0" fabrication drawing shall be submitted for review with the shop drawing submittals of the substitution. Failure to comply with this requirement will result in the shop drawings being returned unchecked.

1.10 COORDINATION DRAWINGS

A. The Contractor shall, in advance of the work, prepare coordination drawings for:

1. Mechanical equipment rooms.

2. Piping and piping chases.

3. Complete fire suppression system piping and sprinkler head layout.

4. Layout of all fire suppression equipment.

B. Show the location of piping openings through the building floors, walls and roofs coordinated with Architectural and Structural, as well as the location and elevations of building fire suppression equipment and systems and piping, coordinated with plumbing, HVAC and electrical systems. Coordination drawings, including plans, elevations and sections, as appropriate, shall clearly show the manner in which the fire suppression systems fit into the available space and coordinates with HVAC and plumbing equipment, ductwork, piping, and electrical equipment, including conduits, light fixtures, motor control centers, transformers, panels, variable frequency drives, etc. Drawings shall demonstrate required code clearances for mechanical and electrical equipments, control panels, etc., and proper operation, maintenance and replacement of fire suppression devices and equipment. Coordination drawings shall be of appropriate scale to satisfy the previously stated purposes, but not smaller than 1/8 inch scale for floor plans and 1/4 scale of equipment rooms and chase areas. Drawings may be composite or may be separate but fully coordinated drawings of the same scale. Every subcontractor must sign-off on coordination drawings prepared by each craft. Failure to sign-off will indicate that subcontractor is proceeding at his own risk. Any cost required to relocate systems to comply with required clearance and equipment installation requirements shall be provided by the Contractor without additional cost under the contract.

C. Seven (7) complete sets of coordination drawings shall be submitted prior to the scheduled start of the work in the area illustrated by the drawings, for the purpose of showing the Contractor's planned method of installation. The objectives of such drawings are to promote carefully planned work sequence and proper coordination, in order to assure the expeditious solutions of problems, and the installation of lines and equipment as contemplated by the contract documents while avoiding or minimizing additional costs to the Contractor and to the Owner.

D. In the event the Contractor, in coordinating the various installations and in planning the method of installation, finds a conflict in location or elevation of any of the mechanical systems, with the structural items or with other construction items, such conflicts shall immediately be documented and submitted for clarification. In doing so, the Contractor shall explain the proposed method of solving the problem, or shall request instructions as to how to proceed if adjustments beyond those of usual trades coordination are necessary.

E. Installation of fire suppression work shall not proceed prior to the submission and completion of the review of the coordination drawings, and any conflicts which are disclosed by the coordination drawings. It is the responsibility of the Contractor to submit the required drawings in a timely manner consistent with the requirements for completing the work covered by this contract within the prescribed contract time.

1.11 USE OF CADD FILES

A. Under certain conditions, the Contractor will be permitted the use of the Engineer's CADD files for documentation of as-builts, submittals, or coordination drawings.

B. The Engineer may require compensation for the time necessary to format the CADD files

delivery to the Contractor. Such work will include removal of title blocks, professional for seals, calculations, proprietary information, etc.

C. The Contractor shall complete the enclosed License, Indemnity and Warranty Agreement, complete with contractor's name, address, and Contractor's Representative signature prior to request for CADD file usage.

1.12 PRIOR APPROVAL

A. Prior approval (approval prior to bid) of alternate mechanical equipment suppliers and service providers is not required. Please do not request prior approval. Alternate manufacturers and service providers may be submitted after bid in accordance with the submittal process provided they meet or exceed the specifications and the indicated design intent.

1.13 GUARANTEE-WARRANTY

A. See Division 1 for warranties.

B. The following guarantee is a part of the specifications and shall be binding on the Contractor:

"The Contractor guarantees that this installation is free from mechanical defects. He agrees to replace or repair any part of the installation which may fail within a period of one year after date established below, provided that such failure is due to defects in the materials or workmanship or to failure to follow the specifications and drawings. Warranty of the Contractor-furnished equipment or systems shall begin on the date the system or equipment is placed in operation for beneficial use of the Owner or occupancy by the Owner, whichever occurs first; such date will be determined in writing, by means of issuing a 'Certificate of Substantial Completion', AIA Form G704," or equivalent.

C. The extent of guarantees or warranties by Equipment and/or Materials Manufacturers shall not diminish the requirements of the Contractor's guarantee-warranty to the Owner.

D. Fire pumps including controllers and transfer switches.

PART 2 - PRODUCTS

2.1 QUALITY OF MATERIALS

A. All equipment and materials shall be new, and shall be the standard product of manufacturers regularly engaged in the production of fire suppression equipment and shall be the manufacturer's latest design. Specific equipment, shown in schedules on drawings and specified herein, is to set forth a standard of quality and operation.

B. Hazardous or Environmentally Damaging Materials: Products shall not contain asbestos, mercury, PCBs, or other materials harmful to people or the environment.

2.2 ALTITUDE RATINGS

A. Unless otherwise noted, all specified equipment capacities are for an altitude of 5395 feet above sea level and adjustments to manufacturer's ratings must be made accordingly.

2.3 ELECTRICAL SERVICES – MOTORS

A. Each motor, unless otherwise specified of 3/4 HP and greater, shall be designed for operation with 3 phase, 60 Hz, 277/480 volt electrical service. Unless otherwise specified, motors of 1/2 hp and less shall be designed for operation with single phase, 60 Hz, 120 volt electrical service. Motors shall be 1750 RPM, squirrel cage, normal starting torque and normal starting current, in accordance with NEMA standards unless otherwise specified.

NEMA EFFICIENCY	
Motor Horsepower	Efficiency, Minimum
5	90.2
7-1/2	91.0
10	91.7
15	92.4
20	93.0
25	92.4
30	93.0
40	93.6
50	93.6
60	93.6
75	95.0

B. All T-frame, ODP motors 5 HP and above shall be premium efficiency motors with a minimum power factor of 0.85 on 1800 RPM motors and a minimum efficiency rating in accordance with IEEE Standard 112, Test Method 'B' as scheduled below. In addition, all motors used in conjunction with variable frequency drives shall be premium efficiency.

C. Motors, including premium efficiency motors shall be manufactured by General Electric Baldor, Louis Allis (Spartan), Marathon, Reliance Electric, Westinghouse, or equivalent having equal efficiencies.

D. Special motors as may be necessary by the application and as specified herein and on the drawings include C-FACE, totally enclosed fan cooled (TEFC), explosion-proof, etc., shall be provided as required and shall be furnished manufacturer's premium efficiency rating for 5 HP and larger.

E. Each motor shall be of the horsepower as specified and suitable for use at an altitude of 5395 feet. All motors shall have grease lubricated sealed ball bearings. Motors larger than 1 HP shall have a standard grease fitting "Zerk" and a separate grease relief tapping. Motors shall be factory lubricated. Motors shall be commercially dynamically balanced and tested at the factory before shipment and shall be selected for quiet operation. The Contractor shall line up motors and drives and place motors and equipment on foundations ready for operation.

F. Unless indicated otherwise, motors shall be NEMA design B with a service factor of 1.15 with 40^{o}C rise and total temperature rise of 65^{o}C ambient and when powered from the system voltage feeding the motor. TEFC motors shall have a service factor of 1.00 with total temperature rise

of 65°C in the above conditions. Motors located in areas exceeding 40°C in the ambient shall be factory rated for the ambient temperature of the motor environment. Single phase motors shall generally be NEMA Type N split phase induction motors with built-in thermal protectors. Unless otherwise specified for a particular application use electric motors with the following requirements.

1. 'Single-phase Motors: Capacitor-start type for hard starting applications. Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC).

2. Polyphase Motors: NEMA Design B, Squirrel cage, induction type. Each two speed motor shall have two separate windings.

3. Rating: Continuous duty at 100% capacity in an ambient temperature of 40°C.

G. If the Division 21 Contractor proposes to furnish motors varying in horsepower and/or characteristics from those specified, he shall first submit his request for the change and shall then coordinate the change with Division 26, Electrical and shall pay all additional charges in connection with the change.

2.4 ELECTRICAL WIRING AND CONTROL EQUIPMENT

A. All wiring and conduit shall be furnished and installed as scheduled in Section 21 0549, Fire Suppression and Electrical Installation Coordination, unless otherwise noted or directed.

B. The Contractor shall coordinate completely with all trades and Sub-Contractors as required to ensure that all necessary components of control work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of such coordination.

C. The fire suppression piping system may be bonded to the electrical ground bus at the electrical service equipment, but shall not under any circumstances be used as the main grounding electrode for the electrical service.

2.5 PAINTING

A. All finish painting of fire suppression systems and equipment will be under "Painting," unless equipment is hereinafter specified to be provided with factory applied finish coats.

B. All equipment shall be provided with factory applied prime finish, unless otherwise specified.

C. Touch-Up: If the factory finish on any equipment is damaged in shipment or during construction of the building, the equipment shall be refinished.

2.6 COUPLING GUARDS

A. All flexibly connected pumps shall be provided with protective steel coupling guards.

2.7 IDENTIFICATION OF VALVES

A. Each valve shall be provided with a stamped metal tag secured to the valve. Tag shall indicate the valve number, the service and function of each valve. The Contractor shall furnish two sets of prints of drawings showing floor plan for each floor with all valves accurately located and labeled. Submitted drawings shall be neat and easily readable. In addition, the Contractor shall provide a valve chart, typed neatly on 8-1/2" x 11" sheets, listing the number, size, location, function, normal operating position, on each valve installed under Division 21. Tags shall be stamped brass 1-1/2" diameter, and secured to valves by heavy copper figure eight hooks, braided stainless steel wire anchor, or other approved means.

B. Division 21 valve tags shall be coordinated with Division 22 and Division 23 valve tags for coordinated format between each division.

2.8 PIPING SYSTEM IDENTIFICATION

A. Means of Identification: All piping shall be identified by each of the means described below. The Contractor shall provide shop drawing submittal data for proposed labeling system materials and manufacturer's recommended installation procedures.

B. Piping Systems shall be identified by means of an identifying legend on color coded background appropriately worded to indicate the "service" name of the pipe as shown on the drawings. Color coded banding shall also be provided. Additionally, an arrow shall be included to indicate the direction of flow through the pipe.

C. Locations of Piping System Identification: The identifying legends and directional arrows described in the paragraphs preceding shall be located at the following points on each piping system:

- Adjacent to each valve in piping system.
- At every point of entry and exit where piping passes through a wall.
- On each pipe riser and junction.
- At a maximum interval of 20 feet on pipe lines exposed and concealed above accessible ceilings.
- Adjacent to all special fittings (regulating valves, etc.) in piping systems.
- At every access door.

D. Piping identification shall meet the standards of the Federal Occupational Safety Health Act (OSHA) which refers to the ANSI Standard A13.1. The following standardized color code scheme shall be used:

Yellow	-	Hazardous Materials
Green	-	Liquid Materials of Inherently Low Hazard
Blue	-	Gaseous Materials of Inherently Low Hazard
Red	-	Fire Protection Materials

E. The size of letter and length of color field shall conform to the ANSI standard and shall be as follows:

Outside Diameter of Pipe or Covering	Length of Color Field	Size of Letters
------ to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"

2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

F. All pipe labels exposed within mechanical equipment spaces shall be semi-rigid plastic identification markers. Each label shall have appropriately color-coded background with printed legend. Directional flow arrows shall be included on label. Labels shall "snap-on" around pipe without the requirement for adhesive or bonding of piping sizes 3/4" through 5". Labels for piping 6" and larger shall be furnished with spring attachment at each end of label. Labels shall be "SETMARK" Type SNA, 3/4" through 5" size and Type STR, 6" and larger, as manufactured by Seton Name Plate Corporation, Brady, or equivalent.

G. All pipe labels except pipe labels located exposed within the mechanical equipment spaces shall be vinyl material with permanent adhesive for application to clear dry pipe and/or insulation jacketing. Each label shall have appropriate color-coded background with printed legend. Direction arrows shall be placed next to label to indicate flow direction. Color and size of arrows shall correspond to that of label. Pressure sensitive pipe tape matching the background color of the label shall be placed over each end of the label and completely around the pipe.

H. Attach pipe markers to lower quarter of the pipe on horizontal runs and on the centerline of vertical piping where view is not obstructed. Flow indicator arrow shall point away from pipe marker.

I. Provide the following labels, with ANSI/OSHA color for all piping systems as shown on the drawings and as listed below:

Service/Legend	Letter Color	Background Color
Fire Protection Water	White	Red
Fire Auto Sprinkler	White	Red
Fire Dry Standpipe	White	Red
Fire Wet Standpipe	White	Red
Fire Combination Standpipe	White	Red

2.9 IDENTIFICATION OF CONTROL SYSTEM DEVICES

A. All automatic controls, control panels, pressure electric, electric pressure switches, relays and starters shall be clearly tagged and identified.

2.10 UNDERGROUND PIPING SYSTEM IDENTIFICATION

A. Bury a continuous, preprinted, bright colored, plastic ribbon cable marker with each underground pipe regardless of whether encased. Locate directly over buried pipe, 6" to 8" below finished grade. Marker tape used in conjunction with buried plastic piping systems shall be special detector type. Marker tape used in conjunction with buried plastic piping systems shall be special detection type.

2.11 ACCESS DOORS

A. Provide all access doors required for access to valves, controls, or other items for which access is required for either operation or servicing. All costs incurred through failure to perform this function as the proper sequence of this work shall be borne by the Contractor. The type of access door shall be as required by the room finish schedule. Acoustical tile access doors shall be equal to Krueger Style B, Style A for acoustical plaster, Style C-CE for sidewall drywall or plaster construction, or Milcor institutional 10 gauge security/detention access door with welded joints, welded butt hinge, with detention type deadbolt lock and tamperproof screws.

B. Access doors shall be not less than 24" x 24" in size except that larger panels shall be furnished where required, and panels in tile or other similar patterned ceilings shall have dimensions corresponding to the tile or pattern module.

C. Where access doors are installed in walls required to have a specific fire rating, the access door installed shall be a fire rated access door with UL label, as manufactured by Milcor or equivalent. Access door in 1-hour construction shall be Class C and access doors in 2-hour construction shall be Class B.

PART 3 - EXECUTION

3.1 COOPERATION WITH OTHER TRADES

A. The Contractor shall refer to other parts of these specifications covering the work of other trades which must be carried on in conjunction with the mechanical work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. The Contractor shall be responsible for the size and accuracy of all openings.

3.2 DRAWINGS

A. The complete design for the project fire suppression system including drawings, hydraulic calculations, piping sizing and arrangement, head layouts, equipment selection, etc., shall be the responsibility of Division 21 Contractor. Preparation of the fire suppression system design shall be in accordance with all Division 21 specification requirements, NFPA requirements and Authorities Having Jurisdiction.

B. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, the question shall be submitted in writing.

C. Installation of all fire suppression equipment and piping systems shall be arranged to provide all clearances required for equipment operation, service, and maintenance, including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC). Piping systems shall not be routed through or above electrical equipment room or electrical equipment space designed within mechanical equipment rooms.

D. The installation of all concealed fire suppression systems shall be carefully arranged to fit within the available space without interference with adjacent mechanical, plumbing, structural and electrical systems. The Contractor shall make all necessary provisions for penetrations of piping, including sleeves and blockouts in structural systems. The exact location of all exposed

fire suppression systems, including access doors; sprinkler piping exposed within finished areas; and other equipment and devices as applicable, shall be coordinated with the Architect, who shall have final authority for the acceptance of the work as it specifically relates to the architectural aesthetic design requirements for the facility. In no instance shall the building vapor barrier system be penetrated by the fire suppression system installation without written approval.

3.3 FIELD MEASUREMENTS

A. The Contractor shall verify the dimensions and conditions governing his work at the building. No extra compensation shall be claimed or allowed on account of differences between actual dimensions, including dimensions of equipment, fixtures and materials furnished, and those indicated on the drawings. Contractor shall examine adjoining work, on which his work is dependent for perfect efficiency, and shall report any work which must be corrected. Coordination of all fire suppression work within the building will be the direct responsibility of the Contractor. Review of submittal data in accordance with paragraph "Submittals" shall in no manner relieve the Contractor of responsibility for the proper installation of the fire suppression work within the available space. Installation of equipment and systems within the building space shall be carefully coordinated by the Division 21 Contractor with all building trades. Each contractor shall so harmonize his work with that of the several other trades that it may be installed in the most direct and workmanlike manner without hindering or handicapping the other trades. Piping interferences shall be handled by giving precedence to pipe lines which require a stated grade for proper operation. Sewer lines shall take precedence over water lines in determination of elevations. In all cases, lines requiring a stated grade for their proper operation shall have precedence over electrical conduit and ductwork. Installation of fire suppression, plumbing and HVAC systems within the ceiling cavity shall be in the following order of priority: plumbing waste lines; roof drains; supply, return, outside air, makeup, and exhaust ductwork; condensate piping; fire sprinkler mains; fire sprinkler branch piping and sprinkler runouts; heating hot water and chilled water piping; domestic hot and cold water; control piping, wiring and conduit; miscellaneous special piping systems.

3.4 EQUIPMENT SUPPORT

A. Contractor shall provide support for equipment to the building structure. Contractor shall furnish all necessary structures, inserts, sleeves, and hanging devices for installation of mechanical and plumbing equipment, ductwork and piping, etc. Contractor shall completely coordinate installation of such devices with all trades and Sub-Contractors. Contractor must further verify that the devices and supports are adequate as intended and do not overload the building's structural components in any way.

3.5 SEISMIC SUPPORTS

A. The Contractor shall be responsible for all anchors and connections for the mechanical work to the building structure to prevent damage of equipment and systems due to earthquakes. The complete fire protection systems shall be supported as required to resist stresses produced by lateral forces as required by NFPA No. 13. Where fire suppression equipment and piping is connected to the building structure, exact method and means of attachment to the structural system shall be approved by the Owner's Representative.

B. See Section 21 0548 for additional requirements for seismic supporting of fire suppression equipment and systems.

3.6 PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be responsible for the protection of all work, materials and equipment furnished and installed under this section of the specifications, whether incorporated in the building or not.

B. Controllers, transfer switches, panels and other items of fire suppression equipment and materials, including piping, valves and fittings, etc., shall be protected from damage and contamination. Equipment and materials shall not be stored outside and exposed to weather and ambient conditions without appropriate protection measures and without the approval of the Owner's Representative. Equipment shall be delivered to the jobsite and maintained while on the jobsite with all openings, controls and control panels covered with heavy duty polyethylene wrap or other proper means. Equipment and materials where stored within the building shall be protected at all times from construction damage and contamination from dust, dirt, debris, and especially during fireproofing, painting and gypboard sanding and finishing. Unprotected equipment and piping will require special field cleaning by the Contractor prior to acceptance by the Architect and Owner's Representative.

C. The Contractor shall provide protection for all work where necessary and shall be responsible for all damage done to property, equipment and materials. Storage of materials within the building shall be approved by the Owner's Representative prior to such storage.

D. Pipe openings shall be closed with caps or plugs, or covered to prevent lodgment of dirt or trash during the course of installation. At the completion of the work, fire suppression equipment and materials shall be cleaned thoroughly and delivered in a condition satisfactory to the Owner's Representative.

3.7 TRENCHING AND BACKFILLING

A. All excavation, trenching and backfilling required for the fire suppression installation shall be provided by this Contractor.

3.8 MANUFACTURER'S INSTRUCTIONS

A. All equipment shall be installed in strict accordance with recommendations of the manufacturer. If such recommendations conflict with plans and specifications, the Contractor shall report such conflicts to the Owner's Representative who shall make such compromises as he deems necessary and desirable.

3.9 CONCRETE BASES AND HOUSEKEEPING PADS

A. Concrete bases and housekeeping pads shall be installed under all pieces of fire suppression equipment unless specifically deleted by the specifications or drawings.

B. Contractor shall be responsible for the accurate dimensions of all pads and bases and shall

furnish and install all vibration isolators, anchor bolts, etc.

C. Contractor shall provide concrete housekeeping pad foundations for all floor mounted equipment installed under this section unless otherwise shown on the drawings. All concrete bases and housekeeping pads shall conform to the requirements specified under Division 3, Concrete, portions of these specifications. Pad foundations shall be 4" high minimum, unless otherwise indicated on the drawings. Chamfer edges shall be 1". Faces shall be free of voids and rubbed smooth with carborundum block after stripping forms. Tops shall be level. Provide dowel rods in floor for lateral stability and anchorage.

D. Equipment anchor bolts shall be set in a galvanized pipe or sheet metal sleeves 1" larger than bolt diameter. Anchor bolts shall be high strength steel J shape. Anchor bolt design shall be arranged and paid for by the Contractor.

E. Machinery bases, bed plates, sole plates, or vibration isolation units shall be carefully aligned, shimmed, leveled, then grouted in place with commercial non-shrink grout. When a flexible coupling is employed as a part of the drive train, the coupling shall be aligned before the machinery base is grouted.

3.10 ALIGNMENT OF FLEXIBLE COUPLINGS

A. Flexible couplings between motors and driven equipment shall be aligned by the qualified service technician after the equipment is installed and ready for operation. Proper aligning shall be provided within manufacturer's maximum alignment tolerance at equipment operating conditions and temperature. Alignment shall follow unit manufacturer's written procedures using approved dial indication methods for parallel and angular alignment. The Contractor shall provide written certification that each device has been so aligned.

3.11 LUBRICATION

A. The Contractor shall provide all oil for the operation of all equipment until acceptance. The Contractor shall be held responsible for all damage to bearings while the equipment is being operated by him up to the date of acceptance of the equipment. The Contractor shall protect all bearings and shafts during installation and shall thoroughly grease the steel shafts to prevent corrosion. Bearings for items of fire suppression equipment shall be marked at each bearing location as to whether the bearing is a sealed type or relubricable type unit.

3.12 TESTS

A. Tests shall be conducted in the presence of the designated and authorized Owner's Representative. The Contractor shall notify the Owner's Representative a minimum of one week in advance of scheduled tests. Requirements for testing are specified under the sections covering the various systems. The Contractor shall furnish all necessary equipment, materials, and labor to perform the required tests.

3.13 INSTALLATION CHECK

A. An experienced, competent, and authorized representative of the equipment listed below shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is approved and accepted.

B. Each equipment supplier's representative shall furnish a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it has operated satisfactorily.

C. Equipment requiring installation check includes the following:

1. Fire pump systems, including controllers and automatic transfer switches.

3.14 OPERATION AND MAINTENANCE INSTRUCTIONS

A. The Contractor shall furnish complete operating and maintenance instructions covering all units of fire suppression equipment herein specified together with parts lists. Equipment spare parts shall include all components requiring service, including motors, bearings, shafts, etc. Furnish two (2) copies of all the literature; each shall be suitably bound in loose leaf book form. A "Lubrication Chart" framed under plexiglass shall be provided listing all types of oil to be used for each piece of equipment and the recommended frequency of lubrication. This chart shall be hung on the wall of the equipment room.

B. See Division 1 for additional requirements concerning manuals, manual distribution, and maintenance materials.

C. Operating and maintenance manuals as required herein shall be submitted for review and distribution to the Owner not less than two (2) weeks prior to the date scheduled for the Contractor to provide Operating and Maintenance Instructions to the Owner as specified herein.

D. Upon completion of all work and all tests, the Contractor shall instruct the Owner or his representative fully in the operations, adjustment and maintenance of all equipment furnished. Contractor shall provide at least two week’s notice in advance of this period, with a written schedule of each training session, the subject of the session, the Contractors' representatives who plan to attend the session, and the time for each session.

E. Equipment startup and operational test shall be conducted by the Contractor with the assistance of the representatives from the fire pump manufacturers and fire pump controller manufacturer. Test shall be conducted in the presence of the designated and authorized Owner's Representative.

3.15 CERTIFICATIONS

A. Before receiving final payment, the Contractor shall certify in writing that all equipment furnished and all work done is in compliance with the contract documents and all applicable codes. Submit certifications and acceptance certificates, including proof of delivery of O&M

manuals, spare parts required, and equipment warranties which shall be bound with O&M manuals.

3.16 INTERRUPTING SERVICES

A. The Contractor shall coordinate the installation of all fire suppression system work in order to minimize interference with the operation of existing building mechanical, plumbing, fire protection, and utility systems during construction. Connections to existing systems requiring the interruption of service within the building shall be carefully coordinated with the Owner to minimize system downtimes. Requests for the interruption of existing services shall be submitted in writing a minimum of two (2) weeks before the scheduled date. Absolutely no interruption of the existing services will be permitted without written review and authorization.

3.17 ONSTRUCTION PHASING AND SCHEDULE

A. All work furnished and installed under Division 21 of this Specification shall be provided in accordance with the project schedule and phase and schedule requirements as described on the Architectural Drawings and Specifications.

3.18 OPERATION PRIOR TO ACCEPTANCE

A. Operation of equipment and systems installed by the Division 21 Contractor for the benefit of the Owner prior to substantial completion will be allowed providing a written agreement between the Owner and the Contractor has established warranty and other responsibilities to the satisfaction of both parties.

B. Operation of equipment and systems installed by the Division 21 Contractor, for the benefit of the Contractor, except for the purposes of testing and balancing will not be permitted without a written agreement between the Owner and the Contractor establishing warranty and other responsibilities.

3.19 SITE VISITS AND OBSERVATION OF CONSTRUCTION

A. The design professional shall make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the Contractor's work, in order to determine in general if such work is proceeding in accordance with the Contract Documents. This observation, however, shall in no way release the Contractor from his complete responsibility to supervise, direct, and control all construction work and activities. The design team has no authority over, or a responsibility to means, methods, techniques, sequences, or procedures of construction provided by the Contractor or for safety precautions and programs, or for failure by the Contractor to comply with all law, regulations, and codes.

END OF SECTION 21 0500

DIVISION 21 SUBSTITUTION REQUEST FORM (SRF)

TO: **BRIDGERS & PAXTON CONSULTING ENGINEERS**

PROJECT: _____

_____

We hereby submit for your consideration the following product instead of the specified item for the above project:

Section _____ Page _____ Paragraph/Line _____ Specified Item _____

Proposed Substitution: _____

Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitutions? YES ☐ NO ☐

If YES, explain

2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions? YES ☐ NO ☐

3. List differences between proposed substitutions and specified item.

_____

_____

4. Does the substitution affect drawing dimensions? YES ☐ NO ☐

5. What affect does substitution have on other trades?

6. Does the manufacturer's warranty for proposed substitution differ from that specified? YES ☐ NO ☐

If YES, explain:

7. Will substitution affect progress schedule? YES ☐ NO ☐

If YES, explain:

8. Will maintenance and service parts be locally available for substitution? YES ☐ NO ☐

If YES, explain

9. Does proposed product contain asbestos in any form? YES ☐ NO ☐

SUBMITTED BY: Firm: Date:

Address:

Signature: Telephone:

For Engineer's Use Only

Accepted_____ Not Accepted _____Received Too Late _____

By: _____Date:_____

Remarks:_____

LICENSE, INDEMNITY AND WARRANTY AGREEMENT

BETWEEN Bridgers & Paxton Consulting Engineers
4600-C Montgomery Blvd NE
Albuquerque, NM 87109

And the Contractor **[NAME]**

[Address]

[Address]

For use of BIM – Building Information Modeling produced by Bridgers & Paxton Consulting Engineers, Inc. (B&P) in conjunction with the referenced project:

PROJECT: **[Project Name and B&P Job #]**

THE CONTRACTOR ACKNOWLEDGES THE FOLLOWING:

1. The model remains the property and control of B&P unless otherwise stipulated in separate contractual agreements with the Architect and/or Owner. Providing access to the model does not transfer copyright or ownership, and is a limited license to use in accordance with these and other conditions set by B&P. The Contract Documents do not require the Contractor to use the model to prepare drawings in electronic format for use during construction, or the use in any way of BIM or CAD systems. The Contractor is not permitted to make alterations to the design model and/or the information contained therein without prior approval from B&P.

2. The model and the information contained is provided as is, the Revit Version 2014 (or earlier version as required by the project) format used by B&P. The model is provided without warranty or guaranty of compatibility with the Contractor's software or hardware systems. Further, the Contractor acknowledges data stored within the model can be altered, wither intentionally or unintentionally, by transcription, machine error, environmental factors, duration, and method of storage, and/or computer operators.

3. The model, and the information contained therein is provided for the Contractor's convenience only, is not a Contract Document and does not relieve the Contractor from the requirements of the Contract Documents. The information provided in the model may not reflect the Contract Documents in all areas and the Contractor will be required to verify where changes have occurred. Also, field verification of existing and as-built conditions are required as part of a submittal process as applicable per project requirements. The official Contract Document set will be used as the precedent and authoritative document, and, in comparison with electronic files, shall supersede any discrepancies, omissions, or errors shown on the electronic files.

4. The design model may contain information provided by others. B&P cannot guarantee or warrant the accuracy and completeness of information provided by others.

5. The information provided in the model is only diagrammatic reflecting design intent. Contract Documents require that the work and coordinated shop drawings reflect actual field verified conditions with actual equipment/duct sizes, utility locations, and related site/project conditions.

6. The Contractor accepts responsibility for ensuring all persons, including sub-contractors, using the model complies with the requirements and limitations in using the information provided to them. Further,

the use of the model is limited solely to this project. Use of the model or contents within on other projects or on other applications by the Contractor is expressly prohibited.

7. This Hold Harmless Agreement shall be attached to and transmitted with the design model at all times so that all those that the Contractor allows to have access are bound by the terms of this Agreement.

ACKNOWLEDGEMENT

1 By accepting the design model and the above stipulations, the Contractor and its agents, employees, Subcontractors of any tier, material suppliers or any others that Contractor allows to access the model agrees to defend, indemnify and hold harmless the Owner and Bridgers & Paxton Consulting Engineers, Inc., their agents, employees against all claims, liabilities, damages, losses, expenses and costs (including expert and attorney's fees) (Claims) arising from, relating to or resulting from their use of the design model (BIM).

ACCEPTED:
CONTRACTOR REPRESENTATIVE

Authorized Signature: _____

Title: _____

Date: _____

BRIDGERS & PAXTON CONSULTING ENGINEERS

Authorized Signature: _____

Title: _____

Date: _____

SECTION 21 0501 - DEMOLITION FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform to applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

1.2 RELATED SECTIONS

A. Section 22 0500 for Common Work Requirements for Fire Suppression.

B. Division 1 for Cutting and Patching.

1.3 SCOPE OF WORK

A. The terms “demolish” and “remove” shall mean disconnect, cart away, and dispose of off site. Components to be demolished or removed include all materials, equipment, building construction, and other components as indicated. Components to be demolished shall become the property of the contractor, and contractor may dispose of them by either landfilling or by selling salvageable parts and recyclable materials to legitimate third parties.

B. Except as specifically noted, asbestos abatement will be by others, and is not included in this contract. Advise Owner sufficiently in advance of demolition work so that Owner may arrange to have asbestos removed without delaying demolition or construction work.

C. The Owner retains the first right of refusal on all components to be removed. When requested, remove components carefully and deposit components in locations as directed by the Owner.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

See Division 23, Section 23 0501 for applicable requirements.

END OF SECTION 21 0501

SECTION 21 0503 - TRENCHING AND BACKFILLING FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

1.2 SCOPE OF WORK

A. The work in this section includes the furnishing of all labor, materials, equipment, transportation, hauling and services required in connection with the excavation, backfilling, compaction, grading and removal of earth from the site required for the installation of the mechanical work specified herein under Division 21.

B. The Contractor shall provide the services of a qualified underground locator to field locate and mark all existing buried utility lines, public and private, piping, conduits, etc., within the required construction area prior to the start of any trenching or excavation work.

1.3 SAFETY REGULATIONS

A. All work performed under this Section shall conform to the requirements of the General Conditions, Supplemental General Conditions and Safety Requirements for this type of work.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

See Division 23, Section 23 0503, for applicable requirements.

END OF SECTION 21 0503

SECTION 21 0504 - PIPE AND PIPE FITTINGS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. Lead Ban: All piping, solder and flux used in the installation of piping systems furnished and installed under Division 21, shall be lead free. The term lead free is defined as pipe which does not contain more than 8.0% lead and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 21 0500 for Common Work Requirements for Fire Suppression.

1.3 SUBMITTAL DATA

A. Contractor shall furnish complete submittal data for all piping materials, including manufacturer's specifications, certifications, class, type and schedule. Submittal data shall additionally be furnished for pipe hangers and supports, seismic restraints, pipe sleeves including sealing and fire safing materials and installation.

PART 2 - PRODUCTS

See Division 23, Section 23 0504, for applicable requirements.

PART 3 - EXECUTION

See Division 23, Section 23 0504, for applicable requirements.

END OF SECTION 21 0504

SECTION 21 0505 - PIPING SPECIALTIES FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Contractor shall furnish and install all piping specialties necessary for satisfactory operation of the systems. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED SECTIONS

A. Section 21 0500, Common Work Requirements for Fire Suppression.

B. Section 21 0504, Pipe and Pipe Fittings for Fire Suppression.

C. Section 21 0523, Valves for Fire Suppression.

D. Section 21 0549, Fire Suppression and Electrical Installation Coordination.

1.3 SUBMITTAL DATA

A. Contractor shall furnish complete submittal data for all piping specialties including manufacturer's specifications, performance characteristics, ratings, installation instructions, certifications and approvals of listing agencies, wiring diagrams, and selection analysis.

PART 2 - PRODUCTS

See Division 23, Section 23 0505, for applicable requirements.

PART 3 - EXECUTION

See Division 23, Section 23 0505, for applicable requirements.

END OF SECTION 21 0505

SECTION 21 0523 - VALVES FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. All Valves shall conform with current applicable provisions of the General Conditions, Supplemental General Conditions, and General Requirements.

B. All Valves shall meet the current MSS Specifications covering Bronze & Iron Valves. MSS-SP-80, MSS-SP-70, MSS-SP71, MSS-SP-85 where applicable.

C. Lead Ban: Valves shall be lead free. The term lead free is defined as valves which do not contain more than 8.0% lead.

1.2 RELATED SECTIONS

A. Section 21 0500, Common Work Requirements for Fire Suppression.

B. Section 21 0523, Valve Identification for Fire Suppression.

C. Section 21 0504, Pipe and Pipe Fittings for Fire Suppression.

D. Division 23 for Valves.

1.3 SCOPE

A. Contractor shall furnish and install all valves and accessories necessary for satisfactory operation of the systems.

1.4 VALVE REQUIREMENTS

A. All Fire Suppression system valves shall be UL Listed and FM Approved. See applicable fire suppression system specification sections for additional valve requirements, including hose threads, tamper switches, etc.

B. All Gate, Globe, Check, Ball valves shall be manufactured by Milwaukee, Nibco, Apollo, Stockham, Powell, Crane, Grinnell, or equivalent.

C. Butterfly valves shall be as manufactured by Milwaukee, W. C. Norris, Centerline, Crane, Demco, Keystone, Grinnell, Victaulic, Nibco, or Dezurik, or equivalent.

PART 2 - PRODUCTS

See Division 23, Section 23 0523, for applicable requirements.

PART 3 - EXECUTION

See Division 23, Section 23 0523, for applicable requirements.

END OF SECTION 21 0523

SECTION 21 0548 - VIBRATION AND SEISMIC CONTROLS FOR FIRE PROTECTION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with the applicable provisions of the General Conditions, Supplemental General Conditions, and General Requirements.

1.2 RELATED SECTIONS

A. Section 21 0500, Common Works Requirements for Fire Suppression.

B. Section 21 0504, Pipe and Pipe Fittings.

C. Section 21 0900, Instrumentation and Control for Fire Suppression System.

1.3 SCOPE

A. It shall be understood that the requirements for seismic restraints are in addition to other requirements as specified elsewhere for the support and attachment of equipment and mechanical services, and for the vibration isolation of same equipment. Nothing on the project drawings or specifications shall be interpreted as justification to waive the requirements for seismic restraint as specified herein, shown on the drawings and required by Code.

B. The work under this section shall include furnishing all labor, materials, tools, appliances and equipment, and performing all operations necessary for the complete execution of the installation of seismic snubber restraint assemblies as shown, detailed and/or scheduled on the drawings and/or specified in this section of the specifications.

C. The materials and systems specified in this section shall be provided by the Contractor from a single Seismic Snubber Restraint Materials Manufacturer to assure sole source responsibility for the performance of the seismic restraints used.

D. The seismic snubber restraint materials manufacturer shall be responsible for detailed design for seismic supports, including calculation for size and attachment, signed and sealed by registered State of New Mexico Structural Engineer.

1.4 SUBMITTALS

A. See Section 21 0500 for general requirements for submittal materials. In addition to the requirements contained in Section 21 0500, provide submittal information for all products and materials covered under this Section of the Specifications as listed herein.

B. Furnish complete catalog data on all vibration isolators, restraints, and equipment vibration bases to be utilized for the project in order to establish compliance with the plans and specifications and all code requirements.

C. Furnish complete shop drawing information including construction details for all vibration bases; support points and anchor bolt requirements and locations; method of support for piping; method of isolation for piping passing through the building structure; and location and arrangement of seismic restraints.

D. Manufacturers not listed as approved in 'Part 2 - Products' must submit for prior approval in accordance with provisions contained in Section 23 0500.

E. Drawings shall be reviewed and certified by a registered Professional Engineer, with a minimum of five (5) years working experience in this field, certifying that the submitted seismic restraint system design and anchorage details complies with all specification requirements and applicable codes.

1.5 CODE REQUIREMENTS

A. Seismic restraints shall be provided for equipment, materials and systems furnished and installed under Division 21 of this Specification in accordance with the requirements of the 2006 International Building Code; and NFPA No. 13 for fire protection system as adopted and interpreted by the State of New Mexico and the City of Farmington.

1.6 SEISMIC RESTRAINT REQUIREMENTS

A. The Contractor shall submit calculations prepared by a State of New Mexico licensed Structural Engineer to substantiate that all items of fire protection equipment and piping systems are properly supported to resist earthquake forces as required herein.

B. All fire protection equipment mounted on vibration isolators shall be provided with seismic restraints securely anchored to the building structure capable of resisting horizontal forces of 100% of their weight and/or in accordance with IBC Requirements.

C. All items of fire protection equipment required for life safety including the fire pump and fire protection systems shall be provided with seismic restraints securely anchored to the building capable of resisting horizontal forces of 100% of their weight and/or in accordance with IBC Requirements.

D. All items of fire protection equipment, except as specified above, and all piping furnished and installed under Division 21 shall be provided with seismic restraints securely anchored to the building capable of resisting horizontal forces of 50% of their weight.

E. Seismic restraint/snubber manufacturer shall be responsible for the structural design of attachment hardware as required to attach seismic restraints/snubbers to both the equipment and supporting structure on vibration isolated equipment, or to directly attach equipment to the building structure for non-isolated equipment.

F. The Contractor shall furnish a complete set of approved shop drawings of all mechanical and electrical equipment which is to be restrained to the seismic restraint manufacturer, from which the

selection and design of seismic restraint devices and/or attachment hardware will be completed. The shop drawings furnished shall include, at a minimum, basic equipment layout, length and width dimensions, installed operating weights of the equipment to be restrained and the distribution of weight at the restraint points.

PART 2 - PRODUCTS

See Division 23, Section 23 0548, for applicable requirements.

PART 3 - EXECUTION

See Division 23, Section 23 0548, for applicable requirements.

END OF SECTION 21 0548

SECTION 21 0549 - FIRE SUPPRESSION AND ELECTRICAL INSTALLATION COORDINATION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED DIVISIONS AND SECTIONS

A. Section 21 0500, Common Work Results for Fire Suppression.

B. Division 22 for Plumbing Systems.

C. Division 23 for Facility Management System.

D. Division 26 for Electrical.

E. Division 28 for Fire Alarm System.

1.3 SCOPE

A. It is the intention of this section to summarize the coordination of effort defined in the related sections and divisions of this specification.

B. If there is a conflict between this Section and other Sections and Divisions of this specification, this Section shall be the governing and decisive Section.

C. Make all connections to motors and controls for equipment supplied and/or installed under Division 21 according to Table 1.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. No work shall be performed until the reviewed and marked submittal data have been reissued to the Contractor, unless written permission is obtained from the Architect.

TABLE 1

Item or System	Note	Supplied By (3)	Installed By (3)	Powered By	Control Field Wiring By
Fused and Non-Fused Disconnects	(1)	Div. 26	Div. 26	Div. 26	N/A
Control Relays & Control Transformers	(1)	Div. 21	Div. 21	Div. 26	Div. 21
Fire Alarm System & Interface w/Fire Suppression Systems		Div. 28	Div. 28	Div. 28	Div. 28
Fire Pump Systems, including main pump & jacket pump control panels, automatic transfer switches and remote monitoring panels		Div. 21	Div. 21	Div. 26	Div. 21
Fire Sprinkler System Control - Supervisory Panels & Devices, Including Tamper Switches & Flow Switches		Div. 21	Div. 21	N/A	Div. 28

TABLE NOTES:

1. Unless specified to be supplied with the equipment

END OF SECTION 21 0549

SECTION 21 1313 - FIRE PROTECTION SYSTEM, AUTOMATIC WET-PIPE SPRINKLER

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplement General Conditions and the General Requirements.

B. Division 3 for concrete work.

C. Division 26 for electrical work and building fire alarm system.

1.2 RELATED SECTIONS

Section 21 0500	Common Work Requirements
Section 21 0503	Trenching and Backfilling for Mechanical Systems
Section 21 0504	Pipe and Pipe Fittings
Section 21 0505	Piping Specialties
Section 21 0523	Valves
Section 22 6801	Outside Utilities
Section 23 0549	Fire Suppression and Electrical Installation Coordination
Section 23 0900	Facility Management System
Section 23 3000	Air Tempering System and Equipment
Section 28 3100	Fire Detection and Alarm

1.3 SCOPE

A. Criteria: This Section covers the requirements for furnishing the design, fabrication, installation, and acceptance testing of a complete automatic wet-pipe sprinkler system.

B. Classification: In accordance with NFPA 13 and 101 requirements and recommendations.

C. Scope of Work: Provide the design, materials, equipment, fabrication, installation, labor, and supervision necessary to install, disinfect, flush, test, and place into service a complete wet-pipe sprinkler system.

1. Fully sprinkle the facility per NFPA-13, the International Building Code, International Fire Code, state and/or local Fire Marshal, and any specific requirements of the Owner's insurance underwriter.

D. Components: Provide all piping, fittings, control valves, check valves, alarm valve (with trim), tamper switches, fire department connection, sprinkler heads, hangers, bracing, test and drain

connections, zone flow switches, tamper switches, accessories and incidentals required for a complete installation in accordance with codes and standards referenced in this Section.

E. Protect all fire lines subject to freezing in a manner approved by NFPA. Use anti-freeze loops only as approved by NFPA and the Local Fire Marshal and only with approved backflow protection in accordance with applicable building codes. Electric heat tape will not be permitted.

F. Conform to the applicable provisions of NFPA Standards 13 and 101. Unless otherwise shown on the Drawings or specified, all materials and equipment used in the installation of the fire protection systems shall be listed in the UL Fire Protection Equipment Directory, and shall be the latest design of the manufacturer. All fire hoses, threads and adapters shall match the standards of the City of Farmington.

G. Provide temporary fire protection within all areas of the building under construction as required by the building codes and the Fire Marshal.

1.4 QUALITY ASSURANCE

A. All materials and equipment used in the installation of the fire protection systems shall be UL listed and/or FM approved for intended use, unless stated otherwise in these specifications.

B. Contractor Qualifications: Contractor shall be experienced, licensed and regularly engaged in the design, fabrication, and installation of automatic fire protection sprinkler systems.

C. Certification: Welders and brazers shall be qualified per the ASME Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.

D. Employ skilled craftspersons and provide proper supervision to ensure the work is erected in a proper manner. Coordinate the work with existing conditions and other disciplines. Visit the premises and thoroughly understand the details of the work and working conditions, and verify all dimensions in the field. If discrepancies are noted which require clarification of the design intent, submit RFIs prior to performing related work. Lay out all work in a manner to avoid all interferences.

E. The drawings show only approximate building outlines and interior construction details as an aid in understanding the scope of work. Follow the drawings as closely as building construction and the work of other trades will permit. Investigate the structural and finish conditions affecting the work and arrange the work accordingly, providing such fittings, traps, valves, and accessories as may be required to meet such conditions. Field verify all dimensions and conditions governing the work.

F. Do not render inoperative any building system without prior approval. Coordinate necessary shutdowns through seven day advanced written notification.

G. Coordinate all fire protection piping and sprinklers with the ceiling or roof materials, lighting, ductwork, conduits, piping, suspended equipment, structural, and other building obstructions to provide an installation in compliance with the appropriate building codes, and NFPA Standards.

1.5 EXISTING CONDITIONS

A. Examine existing conditions and related work required for the design and installation of the fire suppression system.

B. Perform all field tests and inspections as may be necessary to determine water flow, fire protection and pressure characteristics (static and residual pressure and residual flow) necessary for the design and installation of the fire protection system. Contact the water utility to determine whether they anticipate any degradation in the available water source. Prior to starting design, procurement, and installation, submit to the Owner and Engineer a written report documenting the results of this discussion with the water utility.

1.6 OPERATION PRIOR TO ACCEPTANCE

A. The Owner may wish to place portions of the fire suppression systems in service prior to substantial completion. In this case, a written agreement will be prepared establishing warranty and other responsibilities to the satisfaction of both parties.

1.7 SUBMITTALS

A. See Division 1 and Section 21 0500 for general submittal requirements.

B. Within 45 days after the contract is awarded, provide submittal data for the complete fire suppression system for review.

1. Submit sprinkler and standpipe system design drawings and hydraulic calculations to the Fire Marshal, the Building Department AHJ, and the Owner's Insurer for review, comment, and approval.

a. Drawings must be prepared by either a minimum Level 3 NICET Certified Technician, or a professional engineer.

b. Drawings must be stamped by a professional engineer registered in fire protection.

2. Upon receipt of stamped and approved system design drawings and hydraulic calculations from the Fire Marshal, the Building Department AHJ, and the Owner's Insurer, submit required sets of complete submittal data to the Architect as per spec Section 21 0500.

C. Submit complete data describing all equipment and materials to be furnished including performance, quality, dimensions, and certifications of approving agencies. Include plans showing location and arrangement of water supply connection, control valve, fire department connections, alarm bells, tamper switches, on-site fire main routing, on-site fire hydrants and other equipment to be used; and including head layouts coordinated with lighting, plumbing and air conditioning systems. Submittals shall include the following:

1. Shop drawings.

2. Certifications (after installation and tests are completed).

3. Equipment list.

4. Material list.

5. Installation instructions.

6. Maintenance instructions.

7. Operating instructions.

8. Samples, colors.

9. Welder's certification.

10. Catalog data (appropriate unit identified on cut).

11. Recommended spare parts lists.

12. Verifiable calculations.

13. Nameplate data.

D. Complete Package: Submit fire suppression work as a complete package to permit analysis of the system(s) and its components. Partial submittals will not be accepted.

E. Hydraulic Calculations: Submit computerized hydraulic calculations. Maintain a minimum of 10 percent, but not less than a 5 psi buffer below the final water supply curve after accounting for required hose streams, pipe friction elevation differences, etc. Hydraulic design sprinkler system shall be in accordance with the following:

1. Sprinkler System Occupancy Hazard Classifications:
   a. Office and Public Areas: Light Hazard
   b. Storage Areas: Ordinary Hazard
   c. Equipment Rooms: Ordinary Hazard
   d. Service Areas: Ordinary Hazard

2. Minimum Density Requirements for Automatic Sprinkler Hydraulic Design:
   a. Light Hazard Occupancy: 0.10 gpm over 1500 sf area.
   b. Ordinary Hazard, Group 1 Occupancy: 0.15 gpm over 1500 sf area.
   c. Ordinary Hazard, Group 2 Occupancy: 0.20 gpm over 1500 sf area.
   d. Special Occupancy Hazard: As determined by authority having jurisdiction.

F. Shop Drawings: Minimum 1/8" = 1'0" for plans, and 1/4" = 1'0" for details, with minimum 3/16 inch lettering. Show all piping, sprinklers, hangers, flexible couplings, roof construction, electro-mechanical devices, and occupancy of each area, including ceiling and roof heights as required by NFPA 13. Show hydraulic reference points and remote areas.

G. Record Drawings: Provide mylar reproducible record drawings and AutoCAD 2008 files showing all work under this contract. Indicate any special systems or devices such as dry

pendant heads, antifreeze loops, inspector's test connections, etc. Submit record drawings prior to requesting final payment.

1.8 PRODUCT HANDLING

A. Materials and Equipment: Protect materials and equipment from damage during shipping, storage, and installation.

B. Materials and Equipment Installation: Ensure materials and equipment are free of moisture, scale, corrosion, dirt, and other foreign materials prior to installation.

C. Plugs and Cover Plates: Protect flanged openings with gasketed metal cover plates to prevent damage during shipment. Cap or plug all drains, vents, and small piping or gauge connections.

D. Sprinkler Head Protection: Remove frangible bulb protectors after sprinkler heads are installed. Protect sprinkler heads with factory-supplied caps and covers until ceiling installation is complete.

1.9 ENVIRONMENTAL CONDITIONS

A. The sprinkler system and system components shall be designed to operate at an elevation of 5395 feet above sea level.

1.10 ALARM FACILITIES

A. Provide water flow switches and tamper switches. Integrate these and other required sprinkler system alarm devices into the building fire alarm system provided under Division 26. Coordinate with Division 26, Fire Detection and Alarm, regarding the requirements and location of items provided under this section which must be integrated with the fire alarm system.

B. Provide tamper switches on all required valves and devices used in conjunction with the building fire protection system.

1.11 ELECTRICAL CONNECTIONS

A. The fire alarm system will monitor waterflow indicators, tamper switches, etc., provided under this Section.

PART 2 - PRODUCTS

2.1 GENERAL

A. All material and equipment furnished shall be in accordance with the following requirements and NFPA 13. All fire protection materials and equipment shall be new and unused, shall be free of defects and specifically designed for the use intended, shall conform to the requirements

of NFPA 13, and shall be UL listed and FM approved, unless otherwise noted in the Specification.

B. Any deviation to the above requirements shall be submitted to the Architect for approval. The deviation submittal shall be clearly identified as a "deviation."

2.2 PIPING MATERIAL

A. Material Requirement: Automatic sprinkler piping shall be in accordance with this Section and NFPA 13, respectively.

B. Underground piping, to a point 5'0" from the building perimeter, shall be as specified for underground water services in Section 22 6801, Outside Utilities, of this Specification.

C. Underground piping within the building and to a point 5'0" from the building perimeter shall be AWWA Class 200 ductile iron water main pipe and fittings with mechanical joints. Interior of pipe and fittings shall be cement lined. Exterior of pipe and fittings shall be bituminous coating or equivalent. All changes in direction shall be adequately blocked or strapped to prevent separation of joints.

D. Interior building piping systems shall be black steel pipe ASTM A120, or A53 Grade A or B, ERWQ or BW, Standard wall, Schedule 40. UL and FM approved thin wall (Schedule 10, minimum) ASTM A135 or A795 piping may be utilized for sprinkler system as allowed by NFPA and the Fire Marshal. Piping installed outside or exposed to outdoor ambient conditions shall be galvanized.

2.3 FITTINGS

A. Changes of direction shall be accomplished by the use of fittings suitable for use in sprinkler systems as defined in Article 3-13 of NFPA 13. Fittings installed outside or exposed to outdoor ambient conditions shall be galvanized.

B. Fittings and specials for ductile iron pipe shall be Class 250 to match pipe, conforming to AWWA C110, mechanical flange joint type. All ductile iron fittings shall be cement lined.

C. Fittings for steel pipe shall be cast iron screwed, welded fittings, or UL and FM approved mechanical pipe couplings and fittings as manufactured by Victaulic or equivalent in accordance with requirements specified in Section 21 0504.

2.4 JOINTS

A. Joints shall be provided in accordance with Section 21 0504, Pipe and Pipe Fittings, and the manufacturer's instructions. Threaded joints for thin-wall (Schedule 10) piping shall be provided in strict accordance with NFPA requirements, UL and FM approvals for threadable thin-wall piping.

2.5 UNIONS AND FLANGES

A. Unions and flanges shall be provided in accordance with Section 21 0504, Pipe and Pipe Fittings. Gaskets shall be as recommended by the manufacturer and suitable for service on which used.

2.6 HANGERS AND SUPPORTS

A. See Section 21 0504, Pipe and Pipe Fittings, for general requirements associated with equipment piping systems hangers and supports. Seismic supports for fire protection system shall be provided in accordance with NFPA requirements.

B. All fire protection piping shall be rigidly supported from the building structure by means of adjustable ring type hangers. Piping hangers shall be spaced as specified in NFPA 13, Chapter 2. Piping system shall be installed in an approved manner and shall not overload the structure. The Contractor shall provide additional hangers and steel support members as may be required to distribute the piping weight over several structural members where required or directed. Fire protection piping system shall be supported independent and shall not be attached or supported from hangers, trapezes, or supports provided for other piping systems or equipment.

2.7 VALVES

A. See Section 21 0523, Valves, for general valve requirements. All valves for fire hose fire department connections shall have threads and adapters to match the standard of the City of Farmington Fire Department. All valves shall be UL listed and FM approved. Valve sizes shall be determined by the approved hydraulic calculations. Outside screw and yoke valves shall be indicated on the approved hydraulic calculations. Tamper switches shall be provided on all valves controlling fire protection system operation, as required by NFPA. Valves shall be rated for working pressure not less than the maximum pressure to be developed at that point in the system under any operating condition.

B. Gate valves 2" and under, shall be bronze body and trim, outside screw and yoke, wedge disc, screwed connections, 400 psi W.O.G. maximum working pressure.

C. Gate valves, 2-1/2" and larger, shall be Class 125 or Class 250, as required, with flanged ends, outside screw and yoke, bronze seals, wedge disc, iron body.

D. Drain valves shall be globe valve or angle body globe valve, with screwed ends, bronze body and trim, 200 psig W.O.G. maximum working pressure. Furnish and install as required by NFPA No. 13.

E. Swing check valves 2" and smaller shall be y-pattern, horizontal swing bronze body, bronze trim, 200 psig W.O.G. screwed connections.

F. Swing check valves 2-1/2" and larger, shall be iron body, clearway swing check, Class 125 or Class 250 as required with flanged or grooved connections.

G. Automatic Ball Drips: Automatic ball drips shall be 1/2" or 3/4" as required normally open, which close when the flow of water through the valve exceeds 4 to 10 gpm, 175 psig working

pressure, Underwriters' Laboratories, Inc., or Factory Mutual approved, Standard Fire West No. 5248 or equivalent.

H. Post indicator fire main control valve shall be vertical post type for underground valve control provided as shown on the Drawings, Underwriters' Laboratories, and Factory Mutual approved pattern with approved gate valve and tamper switch. Vertical post indicator shall be Mueller Co. Model A-20804 with Mueller AWWA non-rising stem gate valve, A-2050 Series or equivalent.

2.8 ALARM CHECK VALVES

A. Furnish complete wet-pipe sprinkler system alarm check valve assembly with all accessories required for system operation, supervision and alarm. Valves shall be UL listed and FM approved, designed to automatically activate electrically and/or hydraulically operated alarms and shall be furnished in the required size and arrangement with either flanged or grooved connections.

B. Furnish retard chamber, pressure gauges, valves, and trim including water motor gong and alarm switch with both normally open and normally closed electrical contacts.

C. Alarm check valve assembly shall be as manufactured by Tyco Fire Products or equivalent.

2.9 PRESSURE GAUGES

A. Pressure gauges shall be designed for use with water. Gauges shall be of the Bourdon type having an enclosed phosphor-bronze type. The moving parts shall be brass or stainless steel except the hairspring, which is phosphor-bronze. The case and ring shall be brass or stainless steel, and the ring shall be either threaded or pressed over the case. Gauges shall be 4-1/2 inch size with dial marking subdivisions no finer than one percent of the maximum scale reading, and shall be accurate to two percent or less. The gauge scale, when possible, shall be at least twice the maximum working pressure. All gauges shall be FM approved and UL listed.

2.10 TAMPER SWITCHES

A. All valves which control water to automatic sprinkler heads shall be equipped with supervisory switches having one normally open contact and one normally closed contact. Valve supervisory switches shall be single pole double throw switching contacts, and shall be housed in a gasketed weathertight enclosure. The supervisory device supplied shall be specifically designed to mount on, and operate reliably with, the type of control valve being monitored. All valve position switches shall be adjusted to transmit a supervisory signal within two revolutions of the valve operating hand wheel or crank (away from its full open position).

2.11 FLOW SWITCHES

A. Water flow switches shall be field adjustable vane-type with pneumatic retard and 175 psi working pressure. Units shall be single pole double throw, normally open, suitable for 24-volt, DC service or as otherwise required to interface with Building Fire Alarm system. Water flow

switches shall be adjusted so that the device will transmit a water flow alarm within 90 seconds of opening the inspector's test valve on the sprinkler system. The flow switch shall be furnished and installed under this Section of Specifications and electrically connected under Division 26. Flow switches when required for zoning shall be piped and installed so that only one flow switch actuates when an alarm in that zone is present.

2.12 SPRINKLER HEADS

A. Sprinkler heads and accessories shall be UL listed or FM approved for the intended service, regular automatic closed type, 165 deg F rated with 1/2" orifice, except as may be otherwise required for the specific application, and subject to NFPA 13 and 101 requirements and recommendations. Sprinkler heads with higher temperature ratings shall be installed in electrical and mechanical equipment areas, in areas where occupancy may generate high ambient temperatures, where installed in the vicinity of heat producing equipment, attic spaces, where exposed to the direct rays of the sun and beneath skylights and windows, and at other such locations as required by NFPA 13.

B. Sprinkler heads installed in unfinished areas without suspended ceilings shall be upright bronze or brass. Sidewall type heads may be used in areas with low headroom as approved by the Fire Marshal.

C. Sprinkler heads in areas with suspended ceilings including toilet facilities, storage rooms, and similar building spaces shall be chrome plated bronze pendant type or white painted finish as selected by the Architect. Sidewall heads in finished areas shall be horizontal, chrome plated bronze.

D. For all building areas, except as indicated above, furnish concealed sprinkler heads consisting of sprinkler head installed within brass enclosure assembly with cover plate with white finish or satin chrome**,** as approved by the Architect.

E. Supply spare heads of each type as required by NFPA 13. Provide a metal cabinet with a sprinkler head wrench for each type head.

F. Provide sprinkler head guards where required by NFPA 13 and where appropriate.

G. Approved Manufacturers: Tyco Fire Products, Viking, or equivalent.

2.13 SYSTEM ACCESSORIES

A. Fire Department Connections: Fire department connections shall be a 5-inch Storz type and style shown on the plumbing drawings, cast brass body, double clappers, plugs, and attached chains. All exposed surfaces, caps and chains shall be chrome plated. Identification shall be by raised letters on the individual devices, or shall consist of attached escutcheon plates of the same material. Label shall read **"**AUTO SPKR**"**. The dimension from grade level to the center of the 5-inch inlet shall be 34 inches (plus or minus 2 inches).

B. Plaques: Main riser plaques shall be 7 inches by 10 inches with four mounting holes (one in each corner), and shall have white lettering on red porcelain with white blank for the "design data." Plaque shall meet all requirements of NFPA 13, Chapter 7.

C. Strainers: Strainers, where required, shall be "Y" type with cast iron body, 30 mesh monel screen, flanged ends, 1-1/2-inch blow down connection discharging to outside, and shall be rated at 175 psi working pressure for cold water service.

D. Splash Blocks: Splash blocks shall be concrete, 12 inches by 24 inches by 4 inches thick. A commercially available splash block may be provided as a suitable alternate.

2.14 ACCESS DOORS

A. All concealed valves, controls, etc., shall be provided with access doors as specified under Section 21 0500, Common Work Requirements.

PART 3 - EXECUTION

3.1 FIELD CONDITIONS

A. Prior to installation the Contractor shall carefully inspect the installed work of all other trades and verify that all such work is complete to the point where the installation of the sprinkler system may properly commence.

B. The Contractor shall verify that the entire sprinkler system may be installed in accordance with all referenced codes, regulations, standards, and the original approved design.

3.2 INSTALLATION

A. General

1. The complete fire protection system shall be installed in accordance with NFPA 13. The project drawings provide general information concerning the system arrangements, equipment, material, sizes, and other requirements and shall be utilized by the Contractor for this purpose. However, the Contractor shall have complete responsibility for the system design and installation in accordance with the requirements of this Specification.

2. All pipe, fittings, valves, equipment, and accessories shall be visually examined to ensure that they are clean and free of all burrs, cracks, and other imperfections before being installed. During the progress of construction, open ends of pipes, fittings, and valves shall be properly protected at all times to prevent admission of foreign matter.

B. Piping

1. Installation of fire sprinkler piping system shall be in accordance with all applicable requirements contained in Section 21 0500 – Common Work Requirements, Section 21 0504 – Pipe and Pipe Fittings, and Section 21 0505 – Piping Specialties.

2. All fire sprinkler piping shall be so arranged and include such devices to separate the system into individual and distinct alarm zones as shown on the contract drawings and as required by NFPA recommendation and the Fire Marshal. A minimum of one zone per floor will be required unless shown otherwise on the contract drawings.

3. Sprinkler piping shall be marked and identified in accordance with Section 21 0500, Common Work Requirements.

4. The arrangements of all piping systems shall conform to Architectural requirements and field conditions, and shall be run straight and direct, forming right angles or parallel lines with building walls and other pipes, and shall be neatly spaced. Offsets will be provided where required. Standard fittings shall be used for offsets. All risers shall be erected plumb and true, and shall be parallel with the walls and other pipes and shall be neatly spaced. All work shall be coordinated with all Sections of Division 21, 22, and 23, and Division 26, "Electrical," in order to avoid interference of pipe and unnecessary cutting of floors and walls.

5. No pipes or other apparatus shall be installed so as to interfere in any way with the full swing of the building doors, access doors, equipment access, etc.

6. Inspector's test and test pipes shall be piped from the end of the most remote branch line of the automatic sprinkler system to the exterior of the building.

7. When trapped capacity is more than five gallons, provide auxiliary drains consisting of a one-inch valve, nipple, and cap. When trapped capacity is less than five gallons, auxiliary drain shall be one-inch nipple and cap or plug.

8. Provide main drain valves at system alarm valves and extend piping to discharge at exterior at a location approved by the Architect. All pipe and fittings downstream of drain valve shall be galvanized.

9. All concrete penetrations shall be sleeved, then grouted and sealed with fire-resistive material that shall be securely held in place.

C. Welding

1. No field welding of sprinkler piping shall be permitted.

2. Headers, risers, feed, crossmains, and branch lines may be shop welded using approved welding fittings. Welding and brazing shall conform to American National Standard Institute for Power Piping, ANSI B 31.10, with Addenda ANSI B 31.10a and ANSI B 31.10b. Welding and torch cutting shall not be permitted as a means of installing or repairing sprinkler systems.

3. Provide a blind flange at each end of welded headers.

4. Welders and brazers shall be certified for welding and/or brazing in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators. Welders must be certified for work they perform, and certificates shall be checked before the work commences.

D. Alarm Check Valve: Alarm check valves shall be installed with the valve and trim set plumb, and shall be unobstructed. Clear distances shall be as listed below:

Rear:	12 inches
Sides:	18 inches
Front:	24 inches

E. Control Valves: OS&Y fire protection control valves shall be installed so that the stem can be readily seen.

F. Sprinklers and Accessories

1. Sprinkler heads in finished areas are to be installed on a true axis line in both directions with a maximum deviation from the axis line of 1/2" plus or minus. Heads exceeding this shall be removed and reinstalled. Sprinkler heads shall be located in the center of the ceiling tiles, unless otherwise directed.

2. Provide chrome-plated escutcheons where exposed piping passes through finished floors, walls, partitions, and ceilings. Secure plates to pipe with setscrews or spring clips.

3. Provide spare sprinkler head cabinets per NFPA 13.

3.3 EQUIPMENT INSTALLATION

A. Installation of all devices or equipment not specifically covered by these Specifications shall be in accordance with manufacturer's instructions.

3.4 TEMPORARY FIRE PROTECTION

A. During the construction of the building and until the permanent fire extinguishing system has been installed and is in service, temporary fire protection shall be provided as required by the Fire Marshal.

3.5 INSPECTION AND TESTING

A. The complete fire protection systems and piping acceptance testing shall be performed by the Contractor and witnessed. Advance notice shall be given by the Contractor prior to any tests.

B. Inspection Prior to Testing: The Contractor shall submit notification upon completion of the installation of all materials and equipment.

C. Water Piping Disinfection: The Contractor shall furnish all hoses, connections, and equipment to flush piping clear and free of debris and to rinse piping of disinfectant. Flushing per NFPA Figure A-10.10-2.1. All fittings and connections required for water piping, flushing, and disinfection shall be furnished by the Contractor.

D. Chlorine Application: Water from the existing distribution system, or other approved supply source, shall be made to flow at a constant measured rate into the newly installed piping. The water shall receive a minimum chlorine dosage of 300 mg/1. The Contractor shall not allow any anti-freeze glycerine to come in contact with the chlorine. The chlorine shall be applied continuously and for a sufficient period to develop a solid column of chlorinated water that will expose all interior surfaces to a concentration of at least 30 mg/1 for at least three hours. The

application shall be checked at a tap near the downstream end of the line by chlorine residual measure. The chlorine residual measurement test shall be performed by the Contractor and the results submitted.

E. Final Flushing: After the applicable retention period, the heavily chlorinated water in the entire system shall be flushed until the chlorine concentration is not higher than that of the source.

F. Pressure Testing: Pressure tests shall consist of at least flushing, hydrostatic testing, and operation testing and shall be performed in strict accordance with the requirements of NFPA 13. For all above-grade piping, test pressure of 200 psi shall be held for a continuous period of two hours with no drop in pressure. Each complete system (main riser with all associated piping and alarms) shall be tested and accepted as a complete unit. System pressure test shall be against a blank test flange and not against a valve seat. Tests may be conducted by the Contractor on small sections of each complete unit for the benefit of the Contractor. An air pressure test may be provided in accordance with NFPA 13. An air pressure of 40 psig shall be pumped up, allowed to stand 24 hours, and all leaks which allow a loss of pressure over 1.5 psig during the 24 hours shall be fixed.

G. Unsatisfactory Tests: If any of the above tests fail to produce satisfactory results, tests shall be repeated at no additional cost to the Owner until satisfactory results have been obtained.

3.6 CERTIFICATION

A. The Contractor shall certify that the system has been installed in accordance with all referenced codes and standards. The Contractor shall submit this certification upon completion of tests.

3.7 MAINTENANCE AND OPERATING INSTRUCTIONS

A. System description, system theory of operation, and system final inspection and acceptance documents of the completed system shall be submitted in a bound book (four copies). The maintenance manuals and instructions shall include a brief description of the type of system installed, routine-type work defined by step-by-step instructions that should be performed to ensure long life and proper operations, and the recommended frequency of performance. The instructions shall also include possible trouble spots with diagnosis and suggested correction of each. The theory of operation brochures shall describe the function of each component or subassembly. A copy of the completed Contractor's Materials and Test Certificate (reference NFPA-13, Chapter 24) shall be included to document the final inspection, operating test, acceptance and placement of system in service.

END OF SECTION 21 1313

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Division 22 –
Plumbing

SECTION 22 0500 - COMMON WORK REQUIREMENTS FOR PLUMBING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. See General Conditions and Supplemental General Conditions.

B. The requirements listed under General Conditions and Supplemental General Conditions and the General Requirements are applicable to this section and all subsequent Sections of Division 22 and form a part of the contract.

C. Division 21 for Fire Suppression Systems.

D. Division 23 for Heating, Ventilating & Air Conditioning (HVAC) Systems.

E. Division 26 for Electrical Systems.

F. Division 31 for Trenching, Backfilling and Compaction requirements.

G. Division 33 for requirements of site utility systems including sanitary sewer storm, sewer, domestic water distribution system, and natural gas service.

H. All electrical work, regardless of voltage which is provided under Division 22 shall comply with the requirements of the National Electric Code (NEC) and Division 26.

1.2 PLUMBING DIVISION INDEX

Section 22 0500	Common Work Requirements for Plumbing
Section 22 0501	Demolition for Plumbing
Section 22 0502	Installation Of Owner-Supplied Equipment For Plumbing
Section 22 0503	Trenching and Backfilling for Plumbing
Section 22 0504	Pipe and Pipe Fittings for Plumbing
Section 22 0505	Piping Specialties for Plumbing
Section 22 0523	Valves for Plumbing
Section 22 0549	Plumbing and Electrical Installation Coordination
Section 22 0700	Plumbing Insulation
Section 22 1100	Domestic Water Piping
Section 22 1123	Facility Natural Gas System
Section 22 1316	Sanitary Waste and Vent Piping
Section 22 1400	Facility Roof Drainage
Section 22 4000	Plumbing Fixtures and Trim

Section 22 6801 Outside Utilities

1.3 CODES AND PERMITS

A. The plumbing work shall be performed in strict accordance with the applicable provisions of the Uniform Building Code, 2009 Edition; the Uniform Plumbing Code, 2009 Edition; the Uniform Mechanical Code, 2009 Edition and the Uniform Fire Code, 2009 Edition as adopted and interpreted by the State of New Mexico, City of Farmington, and the National Fire Protection Association (NFPA Regulations), current adopted edition, regarding plumbing systems and electrical systems. All materials and labor necessary to comply with rules, regulations and ordinances shall be provided. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. The Contractor shall hold and save the Owner's Representative free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

B. Permits necessary for performance of the work shall be secured and paid for by the Contractor. All utility connections, extensions, meter pits and meter sets and tap fees for water, storm sewer, sanitary sewer and natural gas shall be paid for by the Contractor, unless otherwise specified herein. See Division 33 for all requirements associated with utility permits and fees, connections, extensions, meter pits, and meter sets.

C. The following lists some applicable codes and standards that shall be followed.

Applicable county and state mechanical, electrical, gas, plumbing, health and sanitary codes, laws and ordinances.

National Electrical Manufacturer's Association Standards

National Electrical Code

Underwriters Laboratories, Inc. Standards

American National Standards Institute

American Society for Testing Materials Standards

Standards and requirements of local utility companies.

National Fire Protection Association Standards

American Society of Mechanical Engineers Boiler and Pressure Vessel Codes

Occupational Safety and Health Act

Commercial and Industrial Insulation Standards (MICA)

American Gas Association

The American Society of Sanitary Engineering

National Sanitation Foundation

1.4 RECORD DRAWINGS

A. See Division 1, for requirements associated with Project Record Drawings.

B. The Contractor shall be responsible to maintain a complete and accurate set of marked up prints

showing information on the installed location and arrangement of all plumbing work, and in particular, where changes were made during construction. The Contractor shall be responsible for keeping record drawings accurate and up-to-date throughout the construction period. Record drawings may be reviewed and checked by the Owner's Representative during the construction and in conjunction with review and approval of monthly pay requests. Contractor shall include copies of all addenda, RFI's, bulletins, and change orders neatly taped or attached to record drawing set.

C. After installation and acceptance of direct buried underground piping and service lines in trenches, the Contractor shall take 'as-built' measurements, including all depths, prior to commencement of backfilling operations. It will not be sufficient to check off line locations. Definite measurements shall be taken for each service line. The location of buried piping and trench service lines shall be shown on the drawings and dimensioned from fixed points.

1.5 QUALIFICATIONS

A. All mechanics shall be skilled in their respective trade.

B. All welders shall be certified in accordance with the ASME Boiler Test Code, Section IX, latest issue.

1.6 QUALIFICATION PROCEDURES

The storage, handling, and transportation of all refrigerants, oils, lubricants, etc. shall be accomplished in strict compliance with all State, local, and Federal Regulations including all requirements set forth by the Environmental Protection Agency (EPA) for the safe handling of regulated refrigerants and materials. The Contractor shall utilize qualified and/or certified personnel and equipment as prescribed by these requirements. In no situation shall any refrigerant be discharged to the atmosphere. All refrigerants recovered from all systems shall be disposed of in compliance with these same regulations.

1.7 HAZARDOUS CONDITIONS

A. Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operation personnel, shall be cut back and/or protected to reduce the risk of injury.

1.8 HAZARD SIGNS

A. Equipment rooms, fan plenums, and similar areas containing moving or rotating parts, or other potentially hazardous environments shall include signs on all doors entering such spaces that shall read similar to the following: "Hazardous Area - Authorized Personnel Only."

B. Confined Spaces: Areas designated by OSHA Standard 1910.146 as a confined space shall be marked with a sign that reads "Confined Space - Entry by authorized personnel only, by permit."

1. "Confined Space" means a space that:

   a. Is large enough and so configured that an employee can bodily enter and perform assigned work; and

b. Has limited or restricted means for entry or exit (for example, tanks, vessels, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and

c. Is not designed for continuous employee occupancy.

C. The Contractor shall survey the final premises to determine where any such potentially hazardous areas exist. If the Contractor feels that hazards exist which cannot be suitably provided for through the above typical methods, he shall forward in writing his concerns, and request for a decision concerning the referenced hazard, prior to the final inspection of the facilities.

1.9 SUBMITTALS

A. The Contractor shall submit submittal brochures of all equipment, fixtures and materials to be furnished under Division 22, including but not limited to the following:

1. Piping materials, valves, insulation materials and installation methods, vibration isolation devices, pipe penetration installation methods and products for fire rated assemblies, and all plumbing equipment listed on equipment schedules, and in related construction documents.

2. Materials, certification, shop drawings, and other information as specified in the individual Division 22 Specification Sections within this Specification.

B. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior review or are installed in a manner which is not in conformance with the requirement of this Specification and for which the Contractor has not received a written review, removal of all the unauthorized materials and installation of those indicated or specified shall be provided at no change in contract amount.

C. All equipment shall be installed in accordance with the manufacturer's recommendations. Provide all accessories and components for optimum operation as recommended by the manufacturer.

D. Expense: All costs for the preparation, correction, delivery, and return of the submittals shall be borne by the Contractor.

E. Submittals and one resubmittal will be reviewed by the Architect/Engineer. If the Contractor fails to provide the required data with his second submittal, he will be charged for the third and subsequent reviews.

F. See Division 1 for additional submission requirements.

G. The Contractor shall submit a maximum of seven (7) copies of submittal brochures for review. Brochures shall be submitted within thirty (30) days after contract award. One (1) copy of all submittal data will be retained by the Engineer and one (1) copy will be provided to the Owner's Representative. The remaining copies will be returned to the Owner's Representative. Additional sets of submittals, if required by the Contractor, shall be reproduced by the Contractor from the reviewed and marked sets returned to the Contractor.

H. Complete data must be furnished showing performance, quality and dimensions. No equipment or materials shall be purchased prior to receiving written notification that submittals have been reviewed and marked either "NO EXCEPTIONS TAKEN" or "EXCEPTIONS AS NOTED." Submittals returned marked "EXCEPTIONS AS NOTED" do not require resubmittal provided that

the Contractor agrees to comply with all exceptions noted in the submittal, and so states in a letter.

I. Review of Submittals: Submittals will be reviewed with reasonable promptness, but only for conformance with the design concept of the Project and for conformance with the information indicated on the Drawings and stated in the Specifications. Review of a separate item as such will not indicate review of the assembly in which the item functions. Review of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents, nor for errors or omissions in the submittals; or for the accuracy of dimensions and quantities, the adequacy of connections, and the proper and acceptable fitting, execution, functioning and completion of the work. Review shall not relieve the Contractor of responsibility for the equipment fitting within the allotted space shown on the drawings with all clearances required for equipment operation, service and maintenance including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC). Any relocation of plumbing and/or electrical equipment, materials and systems required to comply with minimum clearances shall be provided by the Contractor without additional cost under the Contract.

J. Shop drawings will be returned unchecked unless the following information is included: cover sheet shall be provided for each submittal of equipment, products and material proposed for use on the project. A common cover sheet for similar equipment (example: all air handling units or all fire protection products) is acceptable. The cover sheet shall list equipment by symbol number; reference all pertinent data in the Specifications or on the drawings; provide size and characteristics of the equipment, name of the project and a space large enough to accept a review stamp. The data submitted shall reflect the actual equipment performance under the specified conditions and shall not be a copy of the scheduled data on the drawings. Cover sheet shall clearly identify any deviations from the specifications for submitted equipment, products, and materials.

K. Use of substitutions reviewed and checked by the Engineer does not relieve the Contractor from compliance with the Contract Documents. Contractor shall bear all extra expense resulting from the use of any substitutions where substitutions affect adjoining or related work required in this Division or other Divisions of this Specification.

L. If Contractor substitutes equipment for that drawn to scale on the drawings, he shall prepare a 1/4" = 1'-0" installation drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, and including piping, and electrical equipment requirements, to verify that equipment will fit space with adequate clearances for maintenance. This 1/4" = 1'-0" fabrication drawing shall be submitted for review with the shop drawing submittals of the substitution. Failure to comply with this requirement will result in the shop drawings being returned unchecked.

1.10 USE OF CADD FILES

A. Under certain conditions, the Contractor will be permitted the use of the Engineer's CADD files for documentation of as-builts, submittals, or coordination drawings.

B. The Engineer shall be compensated for the time required to format the CADD files for delivery to the Contractor. Such work may include removal of title blocks, professional seals, calculations, proprietary information, etc.

C. The Contractor shall complete the enclosed License, Indemnity and Warranty Agreement, complete

with contractor's name, address, and Contractor's Representative signature prior to request for CADD file usage.

1.11 PRIOR APPROVAL

A. Prior approval (approval prior to bid) of alternate mechanical equipment suppliers and service providers is not required. Please do not request prior approval. Alternate manufacturers and service providers may be submitted after bid in accordance with the submittal process provided they meet or exceed the specifications and the indicated design intent.

1.12 GUARANTEE-WARRANTY

A. See Division 1 for warranties.

B. The following guarantee is a part of the specifications and shall be binding on the Contractor:

"The Contractor guarantees that this installation is free from defects. He agrees to replace or repair any part of the installation which may fail within a period of one year after date established below, provided that such failure is due to defects in the materials or workmanship or to failure to follow the specifications and drawings. Warranty of the Contractor-furnished equipment or systems shall begin on the date the system or equipment is placed in operation for beneficial use of the Owner or occupancy by the Owner, whichever occurs first; such date will be determined in writing, by means of issuing a 'Certificate of Substantial Completion', AIA Form G704", or equivalent.

C. The extent of guarantees or warranties by Equipment and/or Materials Manufacturers shall not diminish the requirements of the Contractor's guarantee-warranty to the Owner.

Hot Water Generators
Water Softeners

PART 2 - PRODUCTS

2.1 QUALITY OF MATERIALS

A. All equipment and materials shall be new, and shall be the standard product of manufacturers regularly engaged in the production of plumbing equipment and shall be the manufacturer's latest design. Specific equipment, shown in schedules on drawings and specified herein, is to set forth a standard of quality and operation.

B. Hazardous or Environmentally Damaging Materials: Products shall not contain asbestos, mercury, PCS, or other materials harmful to people or the environment.

2.2 ALTITUDE RATINGS

A. Unless otherwise noted, all specified equipment capacities are for an altitude of 5395 feet above sea level and adjustments to manufacturer's ratings must be made accordingly.

2.3 ELECTRICAL SERVICES - MOTORS

A. Each motor, unless otherwise specified of 3/4 HP and greater, shall be designed for operation with 3 phase, 60 Hz, 277/480 volt electrical service. Unless otherwise specified, motors of 1/2 hp and less shall be designed for operation with single phase, 60 Hz, 120 volt electrical service. Motors shall be 1750 RPM, squirrel cage, normal starting torque and normal starting current, in accordance with NEMA standards unless otherwise specified.

B. All T-frame, ODP motors 5 HP and above shall be premium efficiency motors with a minimum power factor of 0.85 on 1800 RPM motors and a minimum efficiency rating in accordance with IEEE Standard 112, Test Method 'B' as scheduled below. In addition, all motors used in conjunction with variable frequency drives shall be premium efficiency.

NEMA EFFICIENCY	
Motor Horsepower	Efficiency, Minimum
5	90.2
7-1/2	91.0
10	91.7
15	92.4
20	93.0
25	92.4
30	93.0
40	93.6
50	93.6
60	93.6
75	95.0

C. Motors, including premium efficiency motors shall be manufactured by General Electric Baldor, Louis Allis (Spartan), Marathon, Reliance Electric, Westinghouse, or equivalent having equal efficiencies.

D. Special motors as may be necessary by the application and as specified herein and on the drawings include C-FACE, totally enclosed fan cooled (TEFC),explosion-proof, etc., shall be provided as required and shall be furnished manufacturer's premium efficiency rating for 5 HP and larger.

E. Each motor shall be of the horsepower as specified and suitable for use at an altitude of 5395 feet. All motors shall have grease lubricated sealed ball bearings. Motors larger than 1 HP shall have a standard grease fitting "Zerk" and a separate grease relief tapping. Motors shall be factory lubricated. Motors shall be commercially dynamically balanced and tested at the factory before shipment and shall be selected for quiet operation. The Contractor shall line up motors and drives and place motors and equipment on foundations ready for operation.

F. Unless indicated otherwise, motors shall be NEMA design B with a service factor of 1.15 with 40^0C rise and total temperature rise of 65^oC ambient and when powered from the system voltage feeding the motor. TEFC motors shall have a service factor of 1.00 with total temperature rise of 65^oC in the above conditions. Motors located in areas exceeding 40^oC in the ambient shall be factory rated for the ambient temperature of the motor environment. Single phase motors shall generally be NEMA Type N split phase induction motors with built-in thermal protectors. Unless otherwise specified for a particular application use electric motors with the following requirements.

1. Single-phase Motors: Capacitor-start type for hard starting applications. Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC).

2. Polyphase Motors: NEMA Design B, Squirrel cage, induction type. Each two speed motor shall have two separate windings.

3. Rating: Continuous duty at 100% capacity in an ambient temperature of 40°C.

G. If the Division 22 Contractor proposes to furnish motors varying in horsepower and/or characteristics from those specified, he shall first submit his request for the change and shall then coordinate the change with Division 26 and shall pay all additional charges in connection with the change.

H. The Contractor shall ensure proper coordination between motors and variable frequency drives. See Section 22 0550 also.

2.4 ELECTRICAL WIRING AND CONTROL EQUIPMENT

A. All wiring and conduit shall be furnished and installed as scheduled in Section 22 0549, Plumbing and Electrical Installation Coordination, unless otherwise noted or directed.

B. The Contractor shall coordinate completely with all trades and Sub-Contractors as required to ensure that all necessary components of control work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of such coordination.

C. The piping system may be bonded to the electrical ground bus at the electrical service equipment, but shall not under any circumstances be used as the main grounding electrode for the electrical service.

2.5 PAINTING

A. All finish painting of plumbing systems and equipment will be under "Painting," unless equipment is hereinafter specified to be provided with factory applied finish coats.

B. All equipment shall be provided with factory applied prime finish, unless otherwise specified.

C. Touch-Up: If the factory finish on any equipment is damaged in shipment or during construction of the building, the equipment shall be refinished.

2.6 COUPLING GUARDS

A. All flexibly connected pumps shall be provided with protective steel coupling guards.

2.7 IDENTIFICATION OF VALVES

A. Each valve shall be provided with a stamped metal tag secured to the valve. Tag shall indicate the valve number, the service and function of each valve. The Contractor shall furnish two sets of prints of drawings showing floor plan for each floor with all valves accurately located and labeled.

Submitted drawings shall be neat and easily readable. In addition, the Contractor shall provide a valve chart, typed neatly on 8-1/2" x 11" sheets, listing the number, size, location, function, normal operating position, on each valve installed under Division 22. Valves shall be listed by system, i.e. domestic cold water, hot water, chilled water etc. Tags shall be stamped brass 1-1/2" diameter, and secured to valves by heavy copper figure eight hooks, braided stainless steel wire anchor, or other approved means.

B. Division 22 valve tags shall be coordinated with Division 21 and Division 23 valve tags for coordinated format between each Division.

C. Valve tags shall be coordinated with existing facility valve tags and Contractor shall obtain a copy of existing facility valve chart and provide updated valve chart to the Owner's Representative.

2.8 PIPING SYSTEM IDENTIFICATION

A. Means of Identification: All piping shall be identified by each of the means described below. The Contractor shall provide shop drawing submittal data for proposed labeling system materials and manufacturer's recommended installation procedures.

B. Piping Systems shall be identified by means of an identifying legend on color coded background appropriately worded to indicate the "service" name of the pipe as shown on the drawings. Color coded banding shall also be provided. Additionally, an arrow shall be included to indicate the direction of flow through the pipe.

C. Locations of Piping System Identification: The identifying legends and directional arrows described in the paragraphs preceding shall be located at the following points on each piping system:

- Adjacent to each valve in piping system.
- At every point of entry and exit where piping passes through a wall.
- On each pipe riser and junction.
- At a maximum interval of 20 feet on pipe lines exposed and concealed above accessible ceilings.
- Adjacent to all special fittings (regulating valves, etc.) in piping systems.
- At every access door.

D. Piping identification shall meet the standards of the Federal Occupational Safety Health Act (OSHA) which refers to the ANSI Standard A13.1. The following standardized color code scheme shall be used:

Yellow - Hazardous Materials
Green - Liquid Materials of Inherently Low Hazard
Blue - Gaseous Materials of Inherently Low Hazard
Red - Fire Protection Materials

E. The size of letter and length of color field shall conform to the ANSI standard and shall be as follows:

Outside Diameter of	Length of	Size of

Pipe or Covering	Color Field	Letters
------ to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

F. All pipe labels exposed within mechanical equipment spaces shall be semi-rigid plastic identification markers. Each label shall have appropriately color-coded background with printed legend. Directional flow arrows shall be included on label. Labels shall "snap-on" around pipe without the requirement for adhesive or bonding of piping sizes 3/4" through 5". Labels for piping 6" and larger shall be furnished with spring attachment at each end of label. Labels shall be "SETMARK" Type SNA, 3/4" through 5" size and Type STR, 6" and larger, as manufactured by Seton Name Plate Corporation, Brady, or equivalent.

G. All pipe labels except pipe labels located exposed within the mechanical equipment spaces shall be vinyl material with permanent adhesive for application to clear dry pipe and/or insulation jacketing. Each label shall have appropriate color-coded background with printed legend. Direction arrows shall be placed next to label to indicate flow direction. Color and size of arrows shall correspond to that of label. Pressure sensitive pipe tape matching the background color of the label shall be placed over each end of the label and completely around the pipe.

H. Attach pipe markers to lower quarter of the pipe on horizontal runs and on the centerline of vertical piping where view is not obstructed. Flow indicator arrow shall point away from pipe marker.

I. Provide the following labels, with ANSI/OSHA color for all piping systems as shown on the drawings and as listed below:

Service/Legend	Letter Color	Background Color
Domestic Cold Water	White	Green
Domestic Hot Water	Black	Yellow
Domestic Hot Water Return	Black	Yellow
Soft Cold Water	White	Green
Soft Hot Water	Black	Yellow
Industrial (non potable) Cold Water	White	Green
Roof Drain	White	Green
Sanitary Sewer	White	Green
Storm Sewer	White	Green

2.9 IDENTIFICATION OF CONTROL SYSTEM DEVICES

A. All automatic controls, control panels, zone valves, pressure electric, electric pressure switches, relays and starters shall be clearly tagged and identified. Wording shall be identical to that on the control diagram in the contract drawings.

2.10 UNDERGROUND PIPING SYSTEM IDENTIFICATION

A. Bury a continuous, preprinted, bright colored, plastic ribbon cable marker with each underground pipe regardless of whether encased. Locate directly over buried pipe, 6" to 8" below finished grade.

Marker tape used in conjunction with buried plastic piping systems shall be special detector type. Marker tape used in conjunction with buried plastic piping systems shall be special detection type.

2.11 EQUIPMENT TAGS

A. Furnish and install equipment identification tags for all items of PLUMBING equipment furnished and installed under Division 22. Equipment tags shall be a minimum of 3/32" thick laminated phenolic plastic.

2.12 ACCESS DOORS

A. Provide all access doors required for access to valves, controls, or other items for which access is required for either operation or servicing. All costs incurred through failure to perform this function as the proper sequence of this work shall be borne by the Contractor. The type of access door shall be as required by the room finish schedule. Acoustical tile access doors shall be equal to Krueger Style B, Style A for acoustical plaster, Style C-CE for sidewall drywall or plaster construction**,** or Milcor institutional 10 gauge security/detention access door with welded joints, welded butt hinge, with detention type deadbolt lock and tamperproof screws.

B. Access doors shall be not less than 24" x 24" in size except that larger panels shall be furnished where required, and panels in tile or other similar patterned ceilings shall have dimensions corresponding to the tile or pattern module.

C. Where access doors are installed in walls required to have a specific fire rating, the access door installed shall be a fire rated access door with UL label, as manufactured by Milcor or equivalent. Access door in 1-hour construction shall be Class C and access doors in 2-hour construction shall be Class B.

PART 3 - EXECUTION

3.1 COOPERATION WITH OTHER TRADES

A. The Contractor shall refer to other parts of these specifications covering the work of other trades which must be carried on in conjunction with the plumbing work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. The Contractor shall be responsible for the size and accuracy of all openings.

3.2 DRAWINGS

A. The plumbing drawings show the general arrangement of all piping, fixtures, equipment, etc., and shall be followed as closely as actual building construction and work of other trades will permit. Whenever discrepancies occur between plans and specifications, the most stringent shall govern. All Contract Documents, including but not limited to Division 21 Fire Suppression, Division 23 HVAC, and Division 26 Electrical shall be considered as part of the work insofar as this information furnishes the Contractor with details relating to design and construction of the building. Architectural and Structural drawings shall take precedence over the plumbing, HVAC and fire suppression drawings. Because of the small scale of the plumbing, HVAC and fire suppression

drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. The Contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings, valves, and accessories as may be required to meet such conditions. Should conditions necessitate a rearrangement of piping, such departures and the reasons therefore shall be submitted by the Contractor for review in the form of detailed drawings showing the proposed changes. No such changes shall be made without the prior written approval. All changes shall be marked on the set of record drawings by the Contractor.

B. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, the question shall be submitted in writing.

C. Installation of all plumbing equipment and piping systems shall be arranged to provide all clearances required for equipment operation, service, and maintenance, including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC). Piping systems shall not be routed through or above electrical equipment room or electrical equipment space designed within equipment rooms.

D. The installation of all concealed plumbing systems shall be carefully arranged to fit within the available space without interference with adjacent structural and electrical systems. The Contractor shall make all necessary provisions for penetrations of piping, including sleeves and blockouts in structural systems. The exact location of all exposed plumbing systems; access doors; piping exposed within finished areas; and other equipment and devices as applicable, shall be coordinated with the Architect, who shall have final authority for the acceptance of the work as it specifically relates to the architectural aesthetic design requirements for the facility. In no instance shall the building vapor barrier system be penetrated by the plumbing system installation without written approval.

3.3 FIELD MEASUREMENTS

A. The Contractor shall verify the dimensions and conditions governing his work at the building. No extra compensation shall be claimed or allowed on account of differences between actual dimensions, including dimensions of equipment, fixtures and materials furnished, and those indicated on the drawings. Contractor shall examine adjoining work, on which his work is dependent for perfect efficiency, and shall report any work which must be corrected. Coordination of all plumbing work within the building will be the direct responsibility of the Contractor. Review of submittal data in accordance with paragraph "Submittals" shall in no manner relieve the Contractor of responsibility for the proper installation of the plumbing work within the available space. Installation of equipment and systems within the building space shall be carefully coordinated by the Contractor with all building trades. Each contractor shall so harmonize his work with that of the several other trades that it may be installed in the most direct and workmanlike manner without hindering or handicapping the other trades. Piping interferences shall be handled by giving precedence to pipe lines which require a stated grade for proper operation. Sewer lines shall take precedence over water lines in determination of elevations. In all cases, lines requiring a stated grade for their proper operation shall have precedence over electrical conduit and ductwork. Installation of plumbing, HVAC and fire suppression equipment within the ceiling cavity shall be in the following order of priority: plumbing waste lines; roof drains; supply, return, outside air, makeup, and exhaust ductwork; condensate piping; fire sprinkler mains; fire sprinkler branch piping and sprinkler runouts; heating hot water and chilled water piping; domestic hot and cold water; control piping, wiring and conduit; miscellaneous special piping systems.

3.4 EQUIPMENT SUPPORT

A. Contractor shall provide support for equipment to the building structure. Contractor shall furnish all necessary structures, inserts, sleeves, and hanging devices for installation of mechanical and plumbing equipment, ductwork and piping, etc. Contractor shall completely coordinate installation of such devices with all trades and Sub-Contractors. Contractor must further verify that the devices and supports are adequate as intended and do not overload the building's structural components in any way.

3.5 SEISMIC SUPPORTS

A. The Contractor shall be responsible for all anchors and connections for the mechanical work to the building structure to prevent damage of equipment and systems due to earthquakes. The complete fire protection systems shall be supported as required to resist stresses produced by lateral forces as required by NFPA No. 13. Where mechanical equipment, piping, and ductwork is connected to the building structure, exact method and means of attachment to the structural system shall be approved by the Owner's Representative.

B. See Section 22 0548 for requirements for seismic supporting of plumbing equipment and systems.

3.6 PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be responsible for the protection of all work, materials and equipment furnished and installed under this section of the specifications, whether incorporated in the building or not.

B. Plumbing equipment and materials, including piping, valves and fittings, etc., shall be protected from damage and contamination. Equipment and materials shall not be stored outside and exposed to weather and ambient conditions without appropriate protection measures and without the approval of the Owner’s Representative. Equipment and materials shall be delivered to the jobsite and maintained while on the jobsite with all openings, controls and control panels covered with caps, with heavy duty polyethylene wrap or other proper means. Equipment and materials where stored within the building shall be protected at all times from construction damage and contamination from dust, dirt, debris, and especially during fireproofing, painting and gypboard sanding and finishing. Unprotected equipment and piping will require special field cleaning by the Contractor prior to acceptance by the Owner’s Representative.

C. The Contractor shall provide protection for all work where necessary and shall be responsible for all damage done to property, equipment and materials. Storage of materials within the building shall be approved by the Owner's Representative prior to such storage.

D. Pipe openings shall be closed with caps or plugs, or covered to prevent lodgment of dirt or trash during the course of installation. At the completion of the plumbing work, fixtures and materials shall be cleaned and polished thoroughly and delivered in a condition satisfactory to the Owner's Representative.

3.7 TRENCHING AND BACKFILLING

A. All excavation, trenching and backfilling required for the plumbing installation shall be provided by this Contractor.

3.8 MANUFACTURER'S INSTRUCTIONS

A. All equipment shall be installed in strict accordance with recommendations of the manufacturer. If such recommendations conflict with plans and specifications, the Contractor shall report such conflicts to the Owner's Representative, who shall make such compromises as he deems necessary and desirable.

3.9 CONCRETE BASES AND HOUSEKEEPING PADS

A. Concrete bases and housekeeping pads shall be installed under all pieces of plumbing equipment unless specifically deleted by the specifications or drawings.

B. Contractor shall be responsible for the accurate dimensions of all pads and bases and shall furnish and install all vibration isolators, anchor bolts, etc.

C. Contractor shall provide concrete housekeeping pad foundations for all floor mounted equipment installed under this section unless otherwise shown on the drawings. All concrete bases and housekeeping pads shall conform to the requirements specified under Division 3, Concrete, portions of these specifications. Pad foundations shall be 4" high minimum, unless otherwise indicated on the drawings. Chamfer edges shall be 1". Faces shall be free of voids and rubbed smooth with carborundum block after stripping forms. Tops shall be level. Provide dowel rods in floor for lateral stability and anchorage.

D. Equipment anchor bolts shall be set in a galvanized pipe or sheet metal sleeves 1" larger than bolt diameter. Anchor bolts shall be high strength steel J shape. Anchor bolt design shall be arranged and paid for by the Contractor.

E. Machinery bases, bed plates, sole plates, or vibration isolation units shall be carefully aligned, shimmed, leveled, then grouted in place with commercial non-shrink grout. When a flexible coupling is employed as a part of the drive train, the coupling shall be aligned before the machinery base is grouted.

3.10 ALIGNMENT OF FLEXIBLE COUPLINGS

A. Flexible couplings between motors and driven equipment shall be aligned by the qualified service technician after the equipment is installed and ready for operation. Proper aligning shall be provided within manufacturer's maximum alignment tolerance at equipment operating conditions and temperature. Alignment shall follow unit manufacturer's written procedures using approved dial indication methods for parallel and angular alignment. The Contractor shall provide written certification that each device has been so aligned.

3.11 LUBRICATION

A. The Contractor shall provide all oil for the operation of all equipment until acceptance. The Contractor shall be held responsible for all damage to bearings while the equipment is being

operated by him up to the date of acceptance of the equipment. The Contractor shall protect all bearings and shafts during installation and shall thoroughly grease the steel shafts to prevent corrosion. Bearings for items of plumbing equipment shall be marked at each bearing location as to whether the bearing is a sealed type or relubricable type unit.

3.12 PRESSURE RELIEF DEVICES

A. Pressure relief devices and fusible plugs shall be installed with piping to a safe location in accordance with Code requirements.

3.13 TESTS

A. Tests shall be conducted in the presence of the designated and authorized Owner's Representative. The Contractor shall notify the Owner's Representative a minimum of one week in advance of scheduled tests. Requirements for testing are specified under the sections covering the various systems. The Contractor shall furnish all necessary equipment, materials, and labor to perform the required tests.

3.14 INSTALLATION CHECK

A. An experienced, competent, and authorized representative of the equipment listed below shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is approved and accepted.

B. Each equipment supplier's representative shall furnish a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it has operated satisfactorily.

C. Equipment requiring installation check includes the following:

End Suction Pumps
Water Softener
Domestic Water Heaters
Sump Pump and Sewage Pump Systems

3.15 OPERATION AND MAINTENANCE INSTRUCTIONS

A. The Contractor shall furnish complete operating and maintenance instructions covering all units of plumbing equipment fixtures, faucets, etc., herein specified together with parts lists. Equipment spare parts shall include all components requiring service, including motors, bearings, shafts, etc. A "Lubrication Chart" framed under Plexiglass shall be provided listing all types of oil to be used for each piece of equipment and the recommended frequency of lubrication. This chart shall be hung on the wall of the equipment room**.**

B. See Division 1 for additional requirements concerning manuals, manual distribution, and

maintenance materials.

C. Operating and maintenance manuals as required herein shall be submitted for review and distribution to the Owner not less than two (2) weeks prior to the date scheduled for the Contractor to provide Operating and Maintenance Instructions to the Owner as specified herein.

D. Upon completion of all work and all tests, Contractor shall furnish the necessary skilled labor and helpers for operating the plumbing systems and equipment for a period of five (5) days of eight (8) hours each**.** During this period, the Contractor shall instruct the Owner or his representative fully in the operations, adjustment and maintenance of all equipment furnished. Contractor shall provide at least two weeks notice in advance of this period, with a written schedule of each training session, the subject of the session, the Contractors' representatives who plan to attend the session, and the time for each session.

E. Operational test shall be conducted by the Contractor with the assistance of the equipment manufacturer's representative or service technician. Test shall be conducted in the presence of the designated and authorized Owner's Representative.

3.16 CERTIFICATIONS

A. Before receiving final payment, the Contractor shall certify in writing that all equipment furnished and all work done is in compliance with the contract documents and all applicable codes. Submit certifications and acceptance certificates, including proof of delivery of O&M manuals, spare parts required, and equipment warranties which shall be bound with O&M manuals.

3.17 CONSTRUCTION PHASING AND SCHEDULE

A. All work furnished and installed under Division 22 of this Specification shall be provided in accordance with the project schedule and phase requirements as described on the Architectural Drawings and Specifications.

3.18 PLUMBING SYSTEM SHUTDOWN AND REACTIVATION

A. The Contractor shall shutdown existing facility plumbing equipment and piping systems as required for installation of the project plumbing construction work. As a part of the required work, the Contractor shall drain down the existing systems and after completion of new work and pressure testing of systems, the Contractor shall refill the systems and re-establish proper system circulation, remove all air from piping system and equipment, and place system in full and proper operation.

3.19 OPERATION PRIOR TO ACCEPTANCE

A. Operation of equipment and systems installed by the Division 22 Contractor for the benefit of the Owner prior to substantial completion will be allowed providing a written agreement between the Owner and the Contractor has established warranty and other responsibilities to the satisfaction of both parties.

3.20 SITE VISITS AND OBSERVATION OF CONSTRUCTION

A. The design professional shall make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the Contractor's work, in order to determine in general if such work is proceeding in accordance with the Contract Documents. This observation, however, shall in no way release the Contractor from his complete responsibility to supervise, direct, and control all construction work and activities. The design team has no authority over, or a responsibility to means, methods, techniques, sequences, or procedures of construction provided by the Contractor or for safety precautions and programs, or for failure by the Contractor to comply with all law, regulations, and codes.

B. Prior to the "Final" observation visit, the attached "Final Observation Checklist" shall be completed by the Contractor. Any non-applicable items shall be marked "N/A." The completed form shall be submitted, indicating that all necessary items are complete and requesting a final observation within 10 days. The Contractor shall be notified of any uncompleted items within seven (7) days. A resubmittal of the form and a new final observation request by the Contractor is required if the form is returned and noted as incomplete.

END OF SECTION 22 0500

Project:_____ **Date Submitted:**_____

General Contractor:_____ **Date of Final Mechanical System:**_____

Mechanical Contractor:_____ **Observation Requested:**_____

CONTRACTOR'S MECHANICAL & PLUMBING CHECK LIST
(ALL APPLICABLE ITEMS MUST BE COMPLETED PRIOR TO FINAL OBSERVATION)

In advance of requesting a final mechanical observation for installed mechanical systems, please check all items that have been completed. For all items not applicable to this project mark N/A.

HVAC/PIPING

_____1. All plumbing fixtures are set, sealed and cleaned.

_____2. All domestic pipe systems are insulated.

_____3. All pipe systems are identified with specified labels and directional arrows.

_____4. Floor sinks and drain grates are cleaned and debris removed.

_____5. Valve tags are installed.

_____6. Special equipment (water softeners, water heaters, piping systems, etc.) have been checked and put into service.

_____7. Medical gas systems have been checked and certified.

_____8. Special piping systems have been cleaned and pressure tested.

_____	Process Piping	_____	Nitrogen
_____	Compressed Air	_____	Vacuum
_____	Natural Gas	_____	Argon
_____	Other	_____	Medical Gas
		_____	Other

_____9. Limestone chips have been installed in acid dilution sumps.

_____10. Plumbing/piping connections have been completed to Owner furnished equipment and equipment furnished by other Contractors/Sub-Contractors.

_____11. Exterior wall hydrants have been cleaned.

_____12. Concrete collars have been installed at clean-out to grade, valve box, or other specified plumbing items.

_____13. Drains and relief lines from plumbing equipment have been installed and secured in a proper manner.

_____14. All plumbing equipment and areas of equipment have been cleaned and debris removed.

_____15. All plumbing equipment required by the Specifications has been identified and/or numbered.

_____16. Domestic water systems sterilization has been completed.

_____17. Strainers/suction diffusers have been cleaned.

_____18. Backflow preventers have been tested.

_____19. Air has been vented from all systems.

_____20. Ethylene glycol system has been charged with correct mixture and tested.

_____21. Water systems have been cleaned (X) and pressure tested (P).

_____	Non-potable Water	_____	Domestic Hot Water
_____	Domestic Cold Water	_____	Acid Waste and Vent
_____	Sanitary Sewer & Vent	_____	Roof and Overflow Drains
_____	Other (list)		

_____22. PRV's have been adjusted (water, gasses).

PLUMBING EQUIPMENT

_____1. All pump shafts and couplings have been aligned.

_____2. Boilers and domestic water heaters have been fired and tested.

_____3. All plumbing equipment has been lubricated.

_____4. Plumbing equipment has been labeled in accordance with the specifications.

_____5. "HAZARDOUS AREA" signs installed where applicable.

_____6. Variable frequency drives have been tested by the manufacturer's representative and certified to be in compliance with all of the specified requirements.

GENERAL ITEMS

The following specified items have been submitted:

_____1. Record drawings (to be submitted prior to final payment to the Contractor).

_____2. Operation and maintenance manuals.

_____3. Manufacturer's representative installation check and certification submitted (see list of equipment, Section 22 0500).

_____4. Test kits furnished to Owner.

_____ Flow Measuring Devices
_____ Flow Balance Valves
_____ Flow Control Devices

_____5. Control schematics and sequence of operation.

_____6. Plumbing equipment and lubrication, valve, charts have been provided to Owner's Representative.

END CHECKLIST

DIVISION 22 SUBSTITUTION REQUEST FORM (SRF)

TO: **BRIDGERS & PAXTON CONSULTING ENGINEERS, INC.**
PROJECT: _____

We hereby submit for your consideration the following product instead of the specified item for the above project:

Section: _____ Page: _____ Paragraph/Line: _____ Specified Item: _____

Proposed Substitution: _____
_____

Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitutions? YES ☐ NO ☐
   If YES, explain: _____
2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions?
3. List differences between proposed substitutions and specified item.

Specified Item	Proposed Substitution
_____	_____
_____	_____
_____	_____

4. Does substitution affect Drawing dimensions? YES ☐ NO ☐
5. What affect does substitution have on other trades? _____
   _____
6. Does the manufacturer's warranty for proposed substitution differ from that specified? YES ☐ NO ☐
   If YES, explain: _____
   _____
7. Will substitution affect progress schedule? YES ☐ NO ☐
   If YES, explain: _____
   _____
8. Will maintenance and service parts be locally available for substitution? YES ☐ NO ☐
   If YES, explain: _____
   _____
9. Does proposed product contain asbestos in any form? YES ☐ NO ☐

SUBMITTED BY: Firm: _____ Date: _____
Address: _____
Signature: _____ Telephone: _____

For Engineer's Use Only
Accepted _____ Not Accepted: _____ Received too Late: _____
By: _____ Date: _____
Remarks: _____

LICENSE AGREEMENT FOR CADD DATABASE OR BIM MODEL

PROJECT: _____

LICENSE GRANT: Contractor is granted use of the CADD Database or BIM Model (Database/Model) for the indicated project for the specific purpose of preparing submittal documents for this Project. No other use of the Database/Model is granted. Title to the Database/Model is not transferred to the Contractor. The Database/Model may be of value to the Contractor in preparing submittals, but use of the model does not relieve the contractor of the requirement to verify measurements in the field.

COPYING RESTRICTIONS: Contractor may copy the Database/Model in whole or in part, but only for backup and archival purposes or for use by the Contractor's Subcontractors. Contractor agrees to ensure that any entities that receive the Database/Model from Contractor, either in whole or in part, comply with the terms and conditions of this agreement. Contractor shall safeguard the Database/Model from falling into the hands of parties other than Subcontractors with a legitimate need for it.

WARRANTY: Bridgers & Paxton (B&P) offers this Database/Model without warranty and specifically without express or implied warranty of fitness. If Contractor chooses to use the Database/Model, then he does so at his own risk and without any liability or risk to B&P.

INDEMNITY: Contractor shall to the fullest extent permitted by law, defend, indemnify and hold harmless the Owner, Architect, B&P, their employees and agents from all claims, damages, losses, and attorney fees arising out of or resulting from the use of the Database/Model.

ACKNOWLEDGMENT: Contractor acknowledges that (s)he has read this Agreement, understands it, and agrees to be bound by its terms and conditions.

CONTRACTOR'S REPRESENTATIVE

Signature: _____ Company Name: _____

Name: _____ Address 1: _____

Title: _____ Address 2:_____

Date: _____

SECTION 22 0501 - DEMOLITION FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work for Plumbing.

B. Division 1 for Cutting and Patching.

1.3 SCOPE OF WORK

A. The terms "demolish" and “remove” shall mean disconnect, cart away, and dispose of off site. Components to be demolished or removed include all materials, equipment, building construction and other components as indicated. Components to be demolished shall become the property of the contractor, and contractor may dispose of them by either landfilling or by selling salvageable parts and recyclable materials to legitimate third parties.

B. Except as specifically noted, asbestos abatement will be by others, and is not included in this contract. Advise Owner sufficiently in advance of demolition work so that Owner may arrange to have asbestos removed without delaying demolition or construction work.

C. The Owner retains the first right of refusal on all components to be removed. When requested, remove components carefully and deposit components in locations as directed by the Owner.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

See Division 23, Section 23 0501, for applicable requirements.

END OF SECTION 22 0501

SECTION 22 0502 - INSTALLATION OF OWNER-SUPPLIED EQUIPMENT FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 SCOPE OF WORK

A. Provide the following services:

1. General: Work directly with the equipment suppliers. Suppliers shall deliver equipment to a location as designated by Contractor. Coordinate directly with supplier for delivery, rigging requirements, installation requirements, start-up and commissioning. In general, supplier is responsible for delivering the equipment to the site, providing installation instructions, and verifying proper installation. In general the Contractor is responsible for all other work, including unloading equipment, storing equipment until ready for installation, installing the equipment. Start-up and commissioning will require a joint effort by Suppliers and Contractor. Contractor shall relieve the Owner of all responsibilities for coordination with the Suppliers and Shippers.

2. Delivery: Coordinate with suppliers regarding delivery locations and times. Receive, unload, inspect, and immediately report any deficiencies or damage directly to the supplier or shipper, with a copy to the Owner. Resolve such deficiencies or damage directly with the supplier and shipper. Once Contractor accepts delivery, Contractor shall then become fully responsible for equipment.

3. Storage: Where temporary storage is required, store equipment indoors in a heated, dry environment in compliance with manufacturer’s recommendations. If Contractor wishes to store equipment outdoors or in unheated warehouses, request permission in advance from the Owner and Suppliers, comply with manufacturers’ recommendations, and take all measures necessary to ensure that manufacturers’ warranties remain in effect.

4. Installation: Rig equipment into place and install in accordance with manufacturer's recommendations. Take care not to damage building during rigging. Repair any damage to the Owner’s satisfaction. Provide foundations, piping, ductwork, power, controls, etc., as required for a complete installation.

5. Start-up & Commissioning: Coordinate directly with supplier for start-up assistance in sufficient time to support project schedule. Provide all start-up assistance not specifically assigned to supplier. Coordinate the efforts of supplier’s start-up personnel; assist in demonstrating proper capacity, operation and control; and deliver start-up logs to the Owner.

1.3 SCHEDULE

A. See Division 1 for equipment delivery dates.

PART 2 - PRODUCTS

2.1 WNER-SUPPLIED EQUIPMENT

A. See Section "Owner-Supplied Equipment," for specifications and shop drawings of owner-supplied equipment. The following equipment will be supplied by Owner:

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

PART 3 - EXECUTION

See Division 23, Section 23 0502, for applicable requirements.

END OF SECTION 22 0502

SECTION 22 0503 - TRENCHING AND BACKFILLING FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

1.2 SCOPE OF WORK

A. The work in this section includes the furnishing of all labor, materials, equipment, transportation, hauling and services required in connection with the excavation, backfilling, compaction, grading and removal of earth from the site required for the installation of the mechanical work specified herein under Division 22.

B. The Contractor shall provide the services of a qualified underground locator to field locate and mark all existing buried utility lines, public and private, piping, conduits, etc., within the required construction area prior to the start of any trenching or excavation work.

1.3 SAFETY REGULATIONS

A. All work performed under this Section shall conform to the requirements of the General Conditions, Supplementary Conditions and Safety Requirements for this type of work.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

See Division 23, Section 23 0503 – Trenching and Backfilling, for applicable requirements.

END OF SECTION 22 0503

SECTION 22 0504 - PIPE AND PIPE FITTINGS FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.

2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

1.3 SUBMITTAL DATA

A. Contractor shall furnish complete submittal data for all piping materials, including manufacturer's specifications, certifications, class, type and schedule. Submittal data shall additionally be furnished for pipe hangers and supports, seismic restraints, pipe sleeves including sealing and fire safing materials and installation.

PART 2 - PRODUCTS

See Division 23, Section 23 0504 – Pipe and Pipe Fittings, for applicable requirements.

PART 3 - EXECUTION

See Division 23, Section 23 0504 – Pipe and Pipe Fittings, for applicable requirements.

END OF SECTION 22 0504

SECTION 22 0505 - PIPING SPECIALTIES FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Contractor shall furnish and install all piping specialties necessary for satisfactory operation of the systems. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.

2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 0523, Valves for Plumbing.

D. Section 22 0700, Plumbing Insulation.

E. Section 22 0549, Plumbing and Electrical Installation Coordination.

1.3 SUBMITTAL DATA

A. The Contractor shall furnish complete submittal data for all piping specialties including manufacturer's specifications, performance characteristics, ratings, installation instructions, certifications and approvals of listing agencies, wiring diagrams, and selection analysis.

PART 2 - PRODUCTS

See Division 23, Section 23 0505, Piping Specialties.

PART 3 - EXECUTION

See Division 23, Section 23 0505, Piping Specialties.

END OF SECTION 22 0505

SECTION 22 0523 - VALVES FOR PLUMBING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. All Valves shall conform with current applicable provisions of the General Conditions, Supplemental General Conditions, and General Requirements.

B. All Valves shall meet the current MSS Specifications covering Bronze & Iron Valves. MSS-SP-80, MSS-SP-70, MSS-SP71, MSS-SP-85 where applicable.

C. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.

2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Division 21 for Fire Suppression System.

D. Division 22 for Plumbing.

1.3 SCOPE

A. Contractor shall furnish and install all valves and accessories necessary for satisfactory operation of the systems.

1.4 VALVE REQUIREMENTS

A. All Gate, Globe, Check, Ball valves shall be manufactured by Milwaukee, Nibco, Apollo, Stockham, Powell, Crane, Grinnell, or equivalent.

B. All lubricated plug valves shall be as manufactured by Rockwell, Walworth, Homestead, or equivalent.

C. Ball valves shall be utilized in lieu of gate valves and globe valves for all plumbing systems for sizes 2" and smaller.

D. All valves furnish under Division 22 and 23 of the same type shall be products of a single manufacturer unless otherwise approved by Owner's Representative.

E. Provide gate and globe valves with packing that can be replaced with the valve under full working pressure.

F. Provide chain operators for valves 4" and larger installed within mechanical equipment spaces where valves center line is in excess of eight feet above the floor or operating platform and as otherwise indicated on the drawings.

PART 2 - PRODUCTS

See Division 23, Section 23 0523 - Valves, for applicable requirements.

PART 3 - EXECUTION

See Division 23, Section 23 0523 - Valves, for applicable requirements.

END OF SECTION 22 0523

SECTION 22 0549 - PLUMBING AND ELECTRICAL INSTALLATION COORDINATION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

1.2 RELATED DIVISIONS AND SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 23 0900, Facility Management System.

C. Division 26 for Electrical.

D. Division 28 for Electronic Safety and Security.

1.3 SCOPE

A. It is the intention of this section to summarize the coordination of effort defined in the related sections and divisions of this specification.

B. If there is a conflict between this Section and other Sections and Divisions of this specification, this Section shall be the governing and decisive Section.

C. Make all connections to motors and controls for equipment supplied and/or installed under Division 22 according to Table 1 on the following page.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. No work shall be performed until the reviewed and marked submittal data have been reissued to the Contractor, unless written permission is obtained from the Architect.

TABLE 1

Item or System	Note	Supplied By (3)	Installed By (3)	Powered By	Control Field Wiring By
Equipment Motors		Div. 22	Div. 22	Div. 26	N/A
Motor Control Center Including Starters, Pilot Lights, Heater, Switches, Auxiliary Contacts, and Internal Control Wiring		Div. 26	Div. 26	Div. 26	Div.23
Stand Alone Motor Starters (outside motor control centers)	(1)	Div. 26	Div. 26	Div. 26	Div. 23
Variable Frequency Drives (VFD's)		Div. 22	Div. 22	Div. 26	Div. 23
Fused and Non-Fused Disconnects	(1)	Div. 26	Div. 26	Div. 26	N/A
Control Relays & Control Transformers	(1)	Div. 22	Div. 22	Div. 26	Div. 23
Boilers & Domestic Water Heaters		Div. 22	Div. 22	Div. 26	Div. 23
Pressure Booster Pump Systems		Div. 22	Div. 22	Div. 26	Div. 23
Water Softeners & Other Process Water Equipment		Div. 22	Div. 22	Div. 22	N/A
Facility Management System (FMS) for Automatic Control and/or Monitoring of Plumbing System & Equipment	(2)	Div. 23	Div. 23	Div. 26	Div. 23
Medical Gas System - Alarm Panels, Sensors, Pressure Switches	(3)	Div. 22	Div. 22	Div. 26	Div. 22

TABLE NOTES:

1. Unless specified to be supplied with the equipment
2. Division 26 shall coordinate with Division 23, FMS Contractor as required to provide 120 VAC power to each mechanical space and the central plant as necessary for the FMS and as shown on the drawings. Any additional power, transformers, and distribution shall be provided by the Section or Division indicated.
3. Division 22 indicates the plumbing contractor or their designated representative including equipment suppliers, sub-contractors, etc.

END OF SECTION 22 0549

SECTION 22 4000 PLUMBING FIXTURES AND TRIM

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.
   1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
   2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 1100, Domestic Water Piping.

D. Section 22 1316, Sanitary Waste and Vent Piping.

PART 2 - PRODUCTS

2.1 FIXTURES AND EQUIPMENT

A. Vitreous china and enameled cast iron fixtures by American Standard, Kohler, Sloan, Zurn, Mansfield, Toto, or equivalent as listed and described in the plumbing fixture schedule on the drawings. All vitreous china and enameled cast iron fixtures shall be white, unless otherwise indicated on the drawings. The material used for plumbing fixtures shall be of non-absorptive, acid-resistant vitreous china, enameled cast iron or stainless steel, and free from all imperfections. Each water service main, branch main, riser and branch to a group of fixtures shall be valved or as otherwise shown on the drawings to provide more stringent requirements. Stop valves shall be provided at each fixture. One piece chrome plated escutcheons shall be installed on all water piping and trap connections at walls or base cabinets. All exposed connecting piping and material shall be chrome plated.

B. Handicap accessible lavatories and counter mounted sinks shall have exposed supply and waste services insulated with rigid, molded insulation kits as manufactured by T.C.I. "Skal-Gard", Brocar "Trap Wrap", True-Bro "Handi Lav-Guard", McGuire "Prowrap", or equivalent. Provide off-set tail piece fittings on all handicap accessible laboratories and sinks as required.

C. Flush valves shall be low water consumption type as specified on drawings. Valves shall be diaphragm or piston type, with metal oscillating non-hold open handle, screw driver back check angle stop assembly with cap, adjustable tailpiece, vacuum breaker flush connection, and spud couplings as required for wall and fixture rough-in. Exposed flush valves shall be fully chrome plated, with chrome plated supply pipe cover. Flush valves shall be Delany, Sloan Royal, Sloan Regal, Zurn, American Standard, Toto, or equivalent.

D. Closet seats shall be furnished for water closets as specified on the Plumbing Fixture Schedule on the drawings. Closet seats shall be white unless otherwise required to match water closet. All closet seats shall be of smooth non-absorbent material and shall be properly sized for the water closet bowl type. All closet seats for fixtures for public use shall be open-front type without cover. Water closet seats provided for handicapped fixtures shall meet all handicapped requirements. Hinges, posts, nuts, and pintles shall be of a 300 series stainless steel construction. Water closet seats shall be furnished by the plumbing fixture manufacturer as specified on the Fixture Schedule on the drawings, or shall be as manufactured by Bemis, Beneke, Centoco, Church, Olsonite, Sperzel, or equivalent.

E. Floor mounted mop sinks and shower floors shall be as specified on the Plumbing Fixture Schedule on the drawings, molded stone or terrazzo, size and arrangement as shown on the drawings, as manufactured by Acorn, Centoco, Designer's Choice, Fiat, Mustee, Stern-Williams, Zurn, or equivalent.

F. Stainless steel sinks shall be as specified on the Plumbing Fixture Schedule on the drawings and as manufactured by Kohler, American Standard, Elkay, Just, Advance Tabco, Moen, Designers Choice, or equivalent. Countertop sinks indicated within the Architectural drawings to be handicap-compliant shall have an off-centered drain opening and a maximum sink depth of 7-inches. All sink basins shall have a center-rear outlet unless noted otherwise.

G. Electric water coolers (EWC) and drinking fountains shall be as specified on the Plumbing Fixture Schedule on the drawings and as manufactured by Elkay, Haws, Halsey Taylor, Oasis, Westinghouse, Sunroc, Acorn Aqua, or equivalent.

H. Hose bibbs and wall hydrants shall be as specified on the Plumbing Fixture Schedule on the drawings and as manufactured by Zurn, Jay R. Smith, Wade, Woodford, Acorn, Chicago, T&S Brass, Watts, or equivalent. Handles, if specified shall be constructed of metal or brass and finished to match valve unit.

I. Shower valves and mixing valves shall be as specified on the Plumbing Fixture Schedule on the drawings, and as manufactured by Powers, Leonard, Lawler, Speakman, Symmons, Bradley, or equivalent.

J. Emergency fixtures including showers and eyewash shall be as specified on the Plumbing Fixture Schedule on the drawing and as manufactured by Bradley, Chicago, Haws, Speakman, Western, Guardian, Acorn Safety, or equivalent.

2.2 FAUCETS

A. Plumbing fixture faucets shall be brass construction and fully chrome plated, unless special finish is specified on the Plumbing Fixture Schedule on the drawings. Faucets shall be furnished complete with all accessories required for the necessary application, including aerators, handles,

spouts, and operating cartridges. Contractor shall coordinate exact faucet requirements with required fixture drilling and water and waste rough-in. Faucets for handicapped fixtures shall meet all handicapped and ADA requirements, including a maximum of five (5) pounds of force to activate controls and adjustable metering faucet water flow duration of ten (10) seconds, minimum. Single hole faucets shall have anti-clocking pin to prevent rotation of valve body.

B. Plumbing fixture faucets shall be furnished by the fixture manufacturer as specified in the Plumbing Fixture Specification on the drawings and Paragraph 2.1 herein, or shall be as manufactured by Chicago, Delta, Moen, Speakman, T&S Brass, Zurn, or equivalent, and shall be commercial grade.

2.3 PLUMBING FIXTURE TRIM

1. Plumbing fixture trim including P-traps, supplies, and strainers shall be furnished by the fixture manufacturer as specified in the Plumbing Fixture Specification on the drawings and Paragraph 2.1 herein, or shall be as furnished by Chicago, Brass Craft, McGuire, T&S Brass, EBC, Zurn, or equivalent.
2. Unless otherwise specified, traps shall be copper-alloy adjustable tube-type with slip joint inlet and swivel, not less than 20 gauge and without cleanout. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level and swivel joints below the discharge level, metal-to-metal or metal-to-plastic type as required for the application. Outlet shall be threaded or socket for solder joint connection as required by the application. Tailpiece shall be copper-alloy to match P-trap. Furnish brass or copper wall escutcheon at waste penetration through walls. P-traps, tailpieces, escutcheon, and all piping for above floor exposed installations, including installation within cabinets and casework shall be chrome plated.
3. Fixture supplies, strainers, and trim shall be brass construction. Supplies shall be commercial grade, quarter-turn all brass ball valves, plastic stems and handles are not acceptable. Furnish supply with loose key unless otherwise specified. Supply pipe shall be 3/8" O.D., with smooth (non-corrugated) flexible copper riser and wall escutcheon. Supply assembly shall be completely chrome plated for all exposed installations, including installation within cabinets and casework. Strainers and other miscellaneous fixture trim shall be furnished as required for the proper installation and shall be chrome plated to match faucets, unless special finish is required.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall provide all necessary supports and connection materials and trim for plumbing fixtures as required to assure a complete properly installed and operating system. Installation shall be in accordance with manufacturer's recommendations and with International Building Code and Uniform Plumbing Code requirements. The Contractor shall caulk fixtures to the adjacent wall, floor and countertop construction with non-shrink, mildew resistance caulking material.

3.2 EQUIPMENT/FIXTURE SUPPORT

A. Furnish and install all "back-up" materials for fixtures and accessories, or as otherwise required by the equipment schedule to properly support and provide a sturdy installation.

3.3 FIXTURE CARRIERS

A. Fixture carriers shall be provided for all wall hung plumbing fixtures, including water closets, urinals, lavatories, sinks, etc., as manufactured by Josam, Jay R. Smith, Watts, Wade, Zurn, MiFab, or equivalent. Carriers shall be bolted to the floor using all of the support bolts recommended by the manufacturer. Where the water closet nipple and studs extend beyond the maximum carrier recommended length, provide additional carrier support as recommended by manufacturer. Water closet carriers shall be horizontal or vertical, single or back-to-back units as required for the fixture installation and piping arrangement, and shall be adjustable.

B. Single water closet carriers shall have factory installed rear hold down lugs and anchor foot to provide cantilever support.

C. Wall hung urinals shall be provided with floor mounted fixture carrier complete with upper and lower fixture support plates as required to match fixture installation requirements.

D. Wall hung lavatories and sinks shall be provided with floor mounted concealed arm type chair carriers, single or double (back-to-back) units as required for the fixture installation and arrangement.

E. Contractor shall be responsible to provide the proper arrangement and selection of fixture carriers required for fully concealed installation in the available plumbing chase and/or wall construction.

3.4 FOOT PEDALS

A. Plumbing fixture foot pedals, when specified, shall be provided with required back-up support and shall not be installed until wall support methods have been submitted for review.

3.5 EQUIPMENT FURNISHED BY OTHERS

A. The Contractor shall furnish and install complete rough-in and connections, including stop valves on all supply piping for all mechanical services required for equipment furnished and installed under other sections of this specification, and for all owner-furnished equipment.

B. Types of equipment in this category shall include but not be limited to the following: kitchen equipment, shop equipment, hospital and laboratory casework, medical equipment, etc. The Contractor shall provide all pipe fittings, unions, traps, connecting wastes, valves, cocks, regulators, pressure reducing valves, flexible connectors, etc., as required for the services to each piece of equipment.

C. Installation and setting of equipment and fixtures furnished under other Sections of this Specification will not be provided under Division 22 of this Specification, unless otherwise indicated.

3.6 FIELD MEASUREMENTS AND COORDINATION

A. Exact location and rough-in requirements shall be carefully coordinated. Contractor shall refer to drawings and specifications, and shall check manufacturer's data, shop drawings and rough-in drawing submitted

END OF SECTION 22 4000

SECTION 22 6801 – OUTSIDE UTILITIES

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with the applicable provisions of the General Conditions and Supplemental Conditions.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.
   1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
   2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

C. Soldered joints below grade shall be made using Sil-Fos or Phos-Copper.

1.2 SCOPE

A. Domestic Water and Fire Protection Systems.

B. Sanitary and Storm Sewer Systems.

C. Natural Gas System.

1.3 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 0505, Piping Specialties for Plumbing.

D. Section 22 0523, Valves for Plumbing.

E. Section 22 1100, Domestic Water Piping.

F. Section 22 1316, Sanitary Waste and Vent Piping.

G. Section 22 1400, Facility Roof Drainage.

H. Section 22 1123, Facility Natural Gas System.

1.4 GENERAL REQUIREMENTS

A. Excavation and backfilling shall conform to the requirements of Division 2 and Section 22 0503 on Excavation, Trenching, and Backfilling for Utilities. Work covered by this section will not be accepted until backfilling connected with the work has been completed satisfactorily. Any section of the utilities that is found defective in material, alignment, grade, or joints before acceptance shall be corrected. All pipe and accessories shall be of new and unused material. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate the bells and joints. Any pipe that has the grade or joint disturbed after laying shall be taken up and relaid. The interior of the pipe shall be thoroughly cleaned of all foreign matter before being lowered into the trench and shall be kept clean during laying operations by means of plugs or other approved methods. The pipe shall not be laid in water, or when trench or weather conditions are unsuitable for the work. Water shall be kept out of the trench, until the joints are completed. When work is not in progress, open ends of pipe and fittings shall be securely closed so that no trench water, earth or other substance will enter the pipes or fittings. Any section of pipe found to be defective before or after laying shall be replaced with new pipe without additional expense to the Owner. Minimum depth of trench for water piping shall provide 42 inches of cover over the pipe. Minimum depth of trench for gas shall be 30 inches for plastic or 24" for steel.

1.5 UNDERGROUND PIPING IDENTIFICATION

A. The location of each underground piping system shall be marked using a continuous, pre-printed, colored plastic ribbon tracer tape, as specified in Section 22 0500. Additionally, non-metallic underground piping shall be provided with a special detection type tape conforming to applicable Code requirements.

PART 2 - PRODUCTS

2.1 DOMESTIC WATER AND FIRE PROTECTION SYSTEMS

A. General: Provide any of the following optional piping systems unless otherwise indicated on the plans. All pipe and accessories shall be new and unused. Piping, fittings, and specials shall be approved by the National Sanitation Foundation (NSF) for potable water service and shall be listed by UL and FM approved when required for fire protection service.

B. Ductile Iron Pipe, 36" Diameter and Smaller: Ductile iron pipe shall conform to AWWA Spec. C151, working pressure not less than 150 PSIG, unless otherwise shown or required. Pipe shall be cement-mortar lined in accordance with AWWA C104, with exterior bituminous coating. Flanged ductile iron pipe with threaded flanges shall be in accordance with AWWA C115.
   1. Joints: Mechanical joints shall be of the stuffing box type and shall conform to AWWA C110. Push-on joints shall conform to AWWA C110 and C111. Rubber gaskets and lubricant shall conform to the applicable requirements of AWWA C111.
   2. Fittings and Specials: Fittings and specials for ductile iron pipe shall be suitable for 150 PSIG rating, unless otherwise shown or required. Fittings and specials for mechanical joint pipe shall conform to AWWA C110. Fittings and specials for use with push-on joint pipe shall conform to AWWA C110 and C111. Fittings and specials shall be cement lined in accordance with AWWA C104, with exterior bituminous coating. Compact fittings shall

be in accordance with AWWA C153. Flanged joints (in concrete pits, tunnels, and equipment rooms) shall conform to AWWA C115.

C. Polyvinyl chloride (PVC) Plastic Pipe: All pipe, couplings, and fittings shall be manufactured of material conforming to ASTM D1784, Class 12454B.

1. Pipe less than 4" diameter:
   a. Screw-Joint: Pipe to dimensional requirements of ASTM D 1785 Schedule 80, with joints meeting requirements of 150 PSI working pressure, 200 PSI hydrostatic test pressure, unless otherwise shown or required. Pipe couplings when used, must be tested as required by ASTM D 2464.
   b. Elastomeric-Gasket Joint: Pipe shall be to dimensional requirements of ASTM D 1785, Schedule 40 with joints meeting the requirements of 150 PSI working pressure, 200 psi hydrostatic test pressure, unless otherwise shown or specified, or it may be pipe conforming to requirements of ASTM D 2241, elastomeric joint, with the following applications:

SDR	Maximum Working Pressure	Minimum Hydrostatic Pressure
26	100	133
21	120	160
17	150	200
13.5	200	266

   c. In addition to the above requirements, the pipe, couplings and fittings must be hydrostatically tested as required by AWWA C900, and must be to iron pipe (I.P.S.) or cast iron outside diameter (CIOD) size dimensions.
   d. Solvent Cement Joint: Pipe to dimensional requirements of ASTM D 1785 or ASTM D 2241 with joints meeting the requirements of 150 PSI working pressure and 200 PSI hydrostatic test pressure.
2. Pipe 4-Inch through 12-Inch Diameter: Pipe, couplings and fittings 4-inch through 12-inch diameter shall conform to the requirements of AWWA C900, Class 150, CIOD pipe dimensions only, elastomeric-gasket joint only, unless otherwise shown or required.
3. Pipe 14-Inch through 36-Inch Diameter: Pipe shall conform to UBPPA UNI-B-11 unless otherwise shown or required.

D. Joints: Joints, fittings, and couplings shall be as specified for PVC pipe. Joints connecting pipe of differing materials shall be made in accordance with the manufacturer's recommendation as approved by the manufacturer.

E. Fittings:

1. For PVC pipe less than 4-inch diameter: Fittings for threaded pipe shall conform to the requirements of ASTM D 2464, threaded to conform to the requirements of ANSI B1.20.1 for use with Schedule 80 pipe and fittings. Fittings for solvent cement jointing shall conform to ASTM D 2466 or ASTM D 2467. Fittings for elastomeric-gasket joint pipe shall be ductile iron conforming to AWWA C110 or AWWA C111, as specified above for ductile iron pipe.
2. Fittings for PVC pipe 4-inch diameter and larger: Fittings and specials shall be cast iron or ductile iron pipe, bell end in accordance with AWWA C110 or mechanical joints in accordance with AWW C111, 150 PSI pressure rating minimum, except that profile of bell may have special dimensions as required by the pipe manufacturer; or may be fittings and specials of the same material as the pipe with elastomeric gaskets, all in conformance with the requirements of AWWA C900. Cast-iron and ductile iron fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104, with exterior

bituminous coating. Fittings shall be for bell and spigot pipe or plain end pipe, or as applicable. Ductile iron compact fittings shall be in accordance with AWWA C153.

F. Copper Pipe 3-inch and smaller: Type K annealed, soft drawn tubing or hard drawn pipe in accordance with ASTM B88.
   1. Joints: Joints shall be compression pattern flared or solder type using lead-free solder and flux. Surfaces to be soldered shall be cleaned bright by manual or mechanical means. All joints shall be properly fluxed with a non-corrosive lead-free flux manufactured to approved standards, Federal Specification QQ-S-517. Solder joints for underground piping shall be composition silver solder for all sizes.
   2. Fittings: Fittings and specials shall be flared conforming to ANSI B16.26 or wrought copper or cast brass pressure fittings conforming to ANSI B16.22 and B16.23.

G. Gate Valves: Gate valves shall be designed for a working pressure of not less than 150 PSI. Valve connections shall be as required for the piping in which they are installed. Valves shall have a clear waterway equal to the full nominal diameter of the valve, and shall be opened by turning counterclockwise. The operating nut or wheel shall have an arrow, cast in the metal, indicating the direction of opening. Valves shall be furnished in non-rising stem arrangement with two-inch square wrench nut for underground installation. Non-rising stem valves shall be furnished with AWWA stuffing box or with indicator post flange with O-ring seals where indicator post is required. Valves for above ground installation and installation within pits; vaults and tunnels shall be furnished with outside screw and yoke (OS&Y) with non-asbestos packing and hand wheel. Underground valves shall be furnished with either mechanical joint or hub connections as required for the application. OS&Y gate valves shall be furnished with flange connection, Class 125, conforming to ANSI B16.1. Working pressure shall be a minimum of 175 PSIG for valves 4-inch through 12-inch sizes, and 150 PSIG for 14-inch and larger size. All valves for fire protection service shall be UL and FM approved. Underground valves shall be provided with an approved field applied coating as specified for underground steel pipe and fittings.
   1. Valves 3-inch and smaller shall be all bronze designed for screwed fittings, and shall conform to MSS SP-80, Class 150, Type 1. See Section 22 0700.
   2. Valves 4-inch and larger shall be iron body bronze mounted, and shall conform to AWWA C500, with double wedge disc, 4-inch through 14-inch, Mueller A-2050 Series NRS hub ends or mechanical joint ends, and Mueller A-2073 Series OS&Y flange ends, or equivalent. Resilient seat gate valves, 4-inch through 12-inch, shall conform to AWWA C509, Mueller A-2075 Series NRS, hub-ends or mechanical joint ends and Mueller A-2078 Series OS&Y flange ends, or equivalent.

H. Check Valves: Check valves shall be designed for a minimum working pressure of 150 PSI. Valves shall have a clear waterway equal to the full nominal diameter of the valve. Valves shall open to permit flow when inlet pressure is greater than the discharge pressure, and shall close tightly to prevent return flow when discharge pressure exceeds inlet pressure. The size of the valve, working pressure, manufacturer's name, initials, or trademark shall be cast on the body of each valve. All valves shall be UL and FM approved for fire protection service.
   1. Valves 2 inches and smaller shall be all bronze designed for screwed fittings, and shall conform to MSS SP-80, Class 150, Types 3 and 4 as suitable for the application, See Section 22 0523.
   2. Valves 2-1/2 inches and larger shall be iron body, bronze mounted, shall have flanged ends, and shall be the swing check type. Flanges shall be the 125-pound type conforming to ANSI B16.1. Mueller A2120-6 or equivalent.

I. Resilient seated butterfly valves: Resilient seated butterfly valves shall be bubble-tight closing at rated pressure in either direction of flow and shall conform to AWWA C504. Valves shall have cast iron body, ASTM A126, Class B, with mechanical joint ends for underground installation, or ANSI B16.1 flange connection for installation above ground and within pits, vaults, and tunnels. Disc shall be aluminum bronze ASTM A148-952, all shafts shall be stainless steel with self-lubricating corrosion resistant bearings designed for vertical or horizontal shaft loading, non-asbestos packing, and field replaceable synthetic rubber compound valve seats. Valves shall be designed for a minimum 150 PSIG. Furnish gear operator with 2-inch square wrench nut for underground installation with valve disc installed in horizontal arrangement and gear operator with hand wheel for installation above grade and within pits, valves, and tunnels. Valves 3-inch through 24-inch size shall be Keystone Figure 504 (flange ends) and Figure 506 (mechanical joint ends) or equivalent.

J. Indicator Post: Indicator post for fire protection line shall conform to the requirements of NFPA No. 24, shall be adjustable cast iron type, and shall be listed by Underwriters' Laboratories and Factory Mutual approved. Furnish extension section and stem as necessary for required depth of bury and finish grade. Furnish complete with tamper switch as specified in accordance with the requirements in Division 21, Fire Suppression. Electrical connections shall be furnished and installed in accordance with Section 22 0549 and Division 26, Electrical. Indicator Post shall be Mueller Co., Model A-20804, or equivalent.

K. Valve Boxes: Valve boxes shall be cast iron or concrete, except that concrete boxes shall not be installed in locations subject to vehicular traffic.

1. Cast iron valve boxes shall be of the extension type with flared base and shall be two piece, 5-1/4" shaft, screw type, with water cover. The cover shall have the word "WATER" cast in the metal. Boxes shall be installed over each outside gate valve unless otherwise shown on the drawings. The boxes shall be of such length as will provide a cover of not less than 3 ft. over the pipe. Tyler Pipe, 665 Series, or equivalent. The valve box shall be protected against movement by a concrete pad 12 inches square, minimum, and 4" thick.
2. Concrete boxes shall be the standard product of a manufacturer of precast concrete products. The word "WATER" shall be cast in the cover. The boxes shall be of such length as will be required for the depth of cover required over the pipe at the valve location.

L. Valve Pits: Valve pits shall be constructed at locations indicated on the drawings and in accordance with the details shown on the drawings. Concrete shall have compressive strength of 3000 PSI minimum and shall be furnished and installed in accordance with applicable requirements contained within Division 3 for this Specification.

M. Tapping Sleeves and Valves: Wet taps under pressure for connections to existing water mains shall be made using tapping sleeve constructed of cast iron, ductile, or malleable iron, split sleeve type with bolts, follower rings and gaskets on each end of the sleeve, and ANSI B16.1 Class 125 flange connection for tapping valve. Tapping valve outlet connection shall be mechanical joints or hub-end with flange for attachment of required tapping/drilling machine. Valve and sleeve construction shall be for a minimum of 150 PSIG, for 4-inch through 12-inch nominal size, shall conform to AWWA requirements, and shall be UL/FM approved for fire protection service. Mueller H-629 tapping sleeve and H-698 (hub-end) or H-699 (mechanical joint end), or equivalent.

N. Miscellaneous:
   1. Corporation Stops: Corporation stops shall have standard corporation stop thread conforming to AWWA C800 on the inlet end, with flanged joints and compression pattern flared tube couplings for connections to goosenecks.
   2. Goosenecks: Copper tubing for gooseneck connections shall conform to the applicable requirements of ASTM B 88, Type K, annealed. Length of connections shall be in accordance with recommended practice.
   3. Service Stops: Service stops shall be water-works inverted-ground-key type, oval or round flow way, tee handle, without drain. Pipe connections shall be suitable for the type of service pipe used. All parts shall be of bronze with female iron-pipe-size connections or compression-pattern flared tube couplings, and shall be designed for a hydrostatic test pressure not less than 200 PSI.

O. Water Meter:
   1. Domestic water meter assembly shall be furnished and installed by the City of Farmington. Meter size and general arrangement shall be as indicated on the drawings. The Contractor shall coordinate with the applicable City representatives for the installation of the water meters and shall furnish all associated piping, valves, and materials, including meter box/vault in accordance with details on the drawings and City of Farmington requirements. All costs, fees, and permits required for the installation of the water meter shall be secured and paid by the Contractor, unless otherwise indicated.
   2. See Division 2 for water meters.
   3. Water meters shall be furnished and installed by the Contractor in accordance with the information shown on the drawings and in the plumbing equipment and fixture schedule on the drawings.
   4. See Division 23, Section 23 0900, Facility Management System, for meters and instrumentation.

P. Water Meter Box: Water meter box shall be of cast iron or concrete construction of sufficient size to completely enclose the meters, shut-off valves, and associated devices. Height shall extend from invert of meter and water service lines to required finish grade at the meter location. Cover shall have the word "WATER" cast into it. All costs, fees, and permits required for the installation of the meter box shall be secured and paid by the Contractor unless otherwise indicated.

Q. Backflow Protection: All cross-contamination control shall be provided to ensure that no installation of the potable water supply piping system shall be made in a manner that will allow used, unclean, polluted, or contaminated water or substances to enter the domestic potable water system. All backflow devices and assemblies shall be approved by the applicable Administration Authorities and shall be installed according to all applicable codes, regulations, and manufacturer's instructions. Installation shall allow for required access and clearance for required testing, maintenance, and repair.

R. Backflow Preventer Enclosure: Furnish and install factory fabricated backflow preventer enclosure consisting of insulated sheet metal housing with access panel/doors and drain provision. Housing shall be fabricated from galvanized, paint grip sheet metal panels, and faced insulation. Housing shall be supported with heavy gauge galvanized steel angle braces and support members. Panels shall be assembled such that any panel can be removed for access. Furnish hinged access door for required personnel and equipment access into enclosure. Housing insulation shall be minimum 1-1/2" thick closed cell faced insulation with a minimum R-value of 5.8oF, ST/HR/BTU per inch. The housing shall include an integral insulated hinged panel designed to open against hydrostatic pressure. The opening area of the hinged panel shall be sized to comply

with applicable code requirements and to relieve the required discharge from the backflow preventers. The arrangement, size, and location of the enclosure shall be in accordance with details shown on the drawings. Furnish concrete pad for enclosure base and all required supports and anchors necessary for piping and materials within the enclosure. Concrete shall have compressive strength of 3000 PSI minimum, and shall be furnished and installed in accordance with the applicable requirements contained within Division 3 of this specification. Enclosure housing shall be furnished with primer coating for finished painting under the painting sections of this specification. Fully compliant with ASSE 1016. Backflow enclosure shall be by HydroCowl, Hot Box, or equivalent.

1. Backflow preventer enclosure, arranged, size, and location, shall be provided in accordance with the details shown on the drawings, and shall provide access to backflow preventers as recommended by manufacturer for all necessary service, maintenance, and testing.

2.2 SANITARY SEWER SYSTEM

A. General: Provide any of the following optional piping systems unless shown otherwise on the plans. All pipe and accessories shall be new and unused.

B. Cast iron Soil Pipe, 2" through 15" service: Cast iron pipe shall conform to ASTM A-74, service weight, bell and spigot, bituminous coating.
   1. Fittings: Cast iron sanitary drainage fittings, service weight, bell and plain end to match piping system, bituminous coating.
   2. Joints: Joints for cast iron pipe and fittings shall be suitable to match the required piping system and shall be either lead and oakum or double seal compression type molded neoprene rubber gaskets suitable for the class of pipe being jointed.

C. Ductile Iron Pipe, 36" diameter and smaller: Ductile iron pipe shall conform to AWWA C151, exterior bituminous coating.
   1. Fittings: Ductile iron or cast iron fittings to match piping system, bituminous coating.
   2. Joints: Joints for ductile iron pipe and fittings shall be either push-on joint or mechanical joint as specified under Sections for water systems.

D. Polyvinyl chloride (PVC) Sewer Pipe 4" and larger: PVC sewer pipe shall be ASTM D3034, Type PSM, with a maximum SDR of 35 for piping 15" diameter and smaller; ASTM F949 for corrugated sewer pipe with a smooth interior for piping size 4" through 10" diameter; and ASTM F679 for large diameter gravity sewer piping 18" diameter and larger.
   1. Fittings: Fittings for PVC drainage type piping shall be solvent cement or bell and spigot joint in accordance with ASTM D3212, and Uni-Bell UNI-B-4 and B-7, as applicable.
   2. Joints: Joints for PVC piping system shall be either solvent cement type conforming to ASTM D2844, or elastomeric seal type conforming to ASTM D3212.

E. Cement Mortar: Cement mortar shall conform to ASTM C270, Type M, with Type II cement.

F. Portland Cement Concrete: Portland cement shall conform to ASTM C150, sulfate resistant Type II or V, as recommended for the installation, application, and location. Concrete shall conform to ASTM C94, compressive strength shall be a minimum 4000 PSI at 28 days, except for concrete thrust blocking, for cradle and encasement, or for concrete blocks for manholes, which shall have a compressive strength of 2500 PSI minimum at 28 days. Concrete in place shall be protected from freezing and moisture loss for 7 days. Concrete shall be furnished and installed in accordance with the applicable requirements contained within Division 3 of this specification.

2.3 NATURAL GAS SYSTEM

A. The gas distribution system is intended for the distribution of natural gas and the materials, appurtenances and workmanship used in this system shall be suitable and approved for natural gas service. Any section of the gas distribution system that is found defective in materials or workmanship before acceptance shall be corrected.

B. Welders for steel piping shall be certified in accordance with the provision contained within Section 22 0500.

C. Contractor shall have a written procedure approved by the State of New Mexico for installation of polyethylene gas piping. Submit evidence of qualifications prior to commencing work on the natural gas piping system.

D. The gas system shall conform to the applicable requirements of all State of New Mexico codes and ordinances including the Uniform Plumbing Code, and Uniform Mechanical Code, NFPA No. 54, and to the rules and regulations of the Utility Company supplying the gas, including the U.S. Department of Transportation "Pipeline Safety Regulations, Part 192, CFR-49.

E. In shipping, delivering, and installing, pipe and accessories shall be handled in such manner as to ensure a sound, undamaged condition. Particular care shall be taken not to injure pipe and pipe coatings. No pipe or material of any kind shall be placed inside another pipe or fitting after the coating has been applied. Coated and wrapped steel pipe shall be handled in conformance with the American Water Works Association Specification C204.

F. Submit manufacturer's catalog data and installation procedures on pipe, fittings, valves, risers and other material to be incorporated into construction for the natural gas distribution system.

G. Piping: Provide any of the following optional piping systems unless shown otherwise on the plans. All pipe and accessories shall be new and unused.

1. Polyethylene Plastic Pipe: Underground natural gas piping distribution system shall be black or orange polyethylene plastic natural gas distribution pipe with heat fusion joints. Pipe shall be PE-2406, PE-3406, or PE-3408 in accordance with ASTM D2513, as manufactured by POLY-ARK, PLEXCO, Poly-Pipe or equivalent. Contractor shall use the same type and designation of piping throughout the project. Piping shall have approved tracing system (copper 18 gauge wire, or tape) and shall be installed in compliance with all requirements of Authority in jurisdiction.
    a. Risers: Anodeless risers shall consist of polyethylene encased steel pipe sweeps integrally connected to appropriately sized polyethylene pipe at the bury end with threaded IPS connections at the exposed end. Risers shall be as manufactured by Wayne or equivalent. Above ground piping and fittings used to connect to building services shall be black steel, Schedule 40, as specified in Division 23, Section 23 07 00. Incidental below-ground pipe and fittings shall conform to the above specifications and shall be coated and wrapped.
    b. Valves and Valve Boxes: Natural gas main valves shall be plastic valves of the size specified suitable for gas service, compatible with the polyethylene pipe utilized, and conforming to ANSI, Bl6.40, with a minimum working pressure of 125 PSIG, Rockwell or equivalent. Valves shall be installed in cast iron valve box and cover as specified under section for Water Systems, and shall be marked with "GAS" on cover.

H. Gas Meters:
   1. Natural gas meters shall be furnished and installed by the natural gas utility company, unless otherwise indicated on the drawings. All required permits and fees shall be secured and paid for by the Contractor in accordance with Section 22 0500, Common Work Requirements for Plumbing. Gas meter shall be the type of capacity required for the application and shall be located as indicated on the drawings and in accordance with utility company requirements and applicable codes and ordinances. All natural gas meters shall be preceded by a main gas supply shut-off valve serviceable and accessible outside the building.
   2. See Division 23, Section 23 0900, Facility Management Systems, for meters and instrumentation.

I. Natural Gas Regulator:
   1. Natural gas regulator shall be furnished and installed with the gas meter by the utility company, and set for the required gas leaving pressure shown on the drawings.
   2. Natural gas regulators, as specified on the plumbing equipment and fixture schedule and as shown on the drawings, shall be furnished and installed by the Contractor.

PART 3 - EXECUTION

3.1 GENERAL

A. Install utility service lines to a point of connection to the building service lines, approximately five (5) feet outside of the building, and make connections to the building service lines in an approved manner. See the applicable specification sections for requirements associated with the building service lines. All non-metallic piping systems installed under this section of the specification shall terminate approximately five (5) feet from the building and piping system materials approved for installation within the building and specified in the applicable sections shall be provided for connection to the underground utility systems and extension to the building.

B. Installation of utility piping distribution systems including domestic cold water, fire protection, sanitary sewer, storm sewer, and natural gas systems shall be installed as specified herein and in strict accordance with manufacturer's recommendations.

C. In shipping, delivery, and installation pipe and accessories shall be handled in such manner as to ensure sound undamaged condition.

D. Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise authorized. Cutting shall be done by means of an approved type of mechanical cutter. Wheel cutters shall be used whenever possible.

E. Where connections are made between new work and existing mains, the connections shall be made by using specials and fittings to suit the actual conditions. Standard methods are available for making connections to various types of pipe, either under pressure or in the dewatered condition.

F. Pipe passing through walls of vaults, pits, and structures shall be provided with ductile-iron or Schedule 40 steel wall sleeves. Annular space between walls and sleeves shall be filled with rich

cement mortar. Annular space between pipe and sleeves shall be sealed in accordance with requirements contained in Section 22 0504.

G. Flanged pipe shall only be installed above ground or within vaults, pits, or structures only.

3.2 INSTALLATION

A. Piping installation shall conform to the requirements of Section 22 0500, Common Work Requirements for Plumbing, and Section 22 0504, Pipe and Pipe Fittings for Plumbing. Installation of specialties shall conform to the requirements of Section 22 0505, Piping Specialties for Plumbing.

B. Installation of piping and equipment shall be in accordance with applicable codes and regulations, including Uniform Plumbing Code and Uniform Mechanical Code, and NFPA No. 54, Natural Fuel Gas Code.

C. Where the location of the water and sewer lines are not clearly defined in dimensions on the drawings, the water line shall not be laid closer horizontally than ten (10) feet from a sewer except where the bottom of the water line will be at least 12 inches above the top of the sewer line, in which case the water line shall not be laid closer horizontally than six (6) feet from the sewer. Where water lines cross under gravity-flow sewer lines, the sewer pipe for a distance of at least ten (10) feet each side of the crossing shall be fully encased in concrete or shall be made of pipe material approved for use within the building, with no joint located within three (3) feet horizontally of the crossing. Water lines shall in all cases cross above sewage force mains and shall be not less than two (2) feet above the sewer main. Joints in the sewer main, closer horizontally than three (3) feet to the crossing, shall be encased in concrete.

D. Water lines shall not be laid in the same trench with sewer lines, gas lines, fuel lines, or electric systems.

E. Copper tubing shall not be installed in the same trench with ferrous piping materials. Where copper tubing crosses any ferrous piping material, a minimum vertical separation of 12 inches must be maintained between pipes.

F. Where utility piping systems are required to be installed within three (3) feet of existing or new structures, the pipe shall be of a material approved for installation within the building or shall be installed within a sleeve of rigid conduit to a point 10'-0" on either side of the structure. Care shall be exercised and proper precautions taken during installation of the pipe and sleeve to assure that there will be no damage to the structure and no settlement or movement of foundations or footings. Any damage occurring as a result of the Contractor's operation shall be corrected and all costs connected therewith shall be borne by the Contractor.

3.3 JOINT DEFLECTION

A. Cast Iron and Ductile Iron Pipe: The maximum allowable deflection will be as given in AWWA C600 and as recommended by the manufacturer. If the alignment requires deflection in excess of the above limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth.

B. Plastic Pipe: Maximum offset in alignment between adjacent pipe joints shall be as recommended by the manufacturer, but in no case shall it exceed five (5) degrees.

3.4 DOMESTIC WATER AND FIRE PROTECTION SYSTEMS

A. Placing and Laying: While suspended in the sling and before lowering into the trench, the pipe shall be inspected for defects and tapped with a light hammer to detect cracks. Defective, damaged, or unsound pipe will be rejected. As the work progresses, the interior of the piping shall be cleared of all dirt and debris. Trenches shall be kept free from water until the pipe jointing has been completed. Pipe shall not be laid when the condition of the trench or the weather is unsuitable for such work. At all times when the work is not in progress, all open ends of pipe and fittings shall be maintained securely closed. Unless in conflict with other provisions of these specifications, Section 7 of AWWA C600-54T shall apply in placing and laying of ductile iron pipe. Minimum depth of cover over buried water lines shall be three (3) feet.

B. Jointing:
   1. Copper Tubing: Joints shall be made with solder or flared fittings. The flared end tube shall be pulled tightly against the tapered part of the fitting by a nut which is part of the fitting, so there is metal-to-metal contact. Solder joints shall be composition silver solder as specified in Sections 22 0504 and 22 1100.
   2. Ductile-Iron Pipe: Mechanical and push-on type joints shall be installed in accordance with AWWA C600 for buried lines.

C. Polyvinyl Chloride (PVC) Plastic Pipe:
   1. (PVC) Plastic Pipe Less Than 4-Inch Diameter: Threaded joints shall be made by wrapping the male threads with approved thread tape or applying an approved lubricant, then threading the joining members together. The joint shall be tightened using strap wrenches to prevent damage to the pipe and/or fitting. To avoid excessive torque, joints shall be tightened no more than one thread past hand-tight. Preformed rubber-ring gaskets for elastomeric-gasket joints shall be made in accordance with requirements of ASTM F 477 and as required herein. All pipe ends for push-on joints shall be beveled to facilitate assembly and marked to indicate when the pipe is fully seated. The gasket shall be prelubricated to prevent displacement. Care shall be exercised to assure the gasket and ring groove in the bell or coupling match. The manufacturer of the pipe or fitting shall also supply the elastomeric gasket. Couplings shall be provided with stops or centering rings to assure that the coupling is centered on the joint. Solvent cement joints shall utilize sockets conforming to the requirements of ASTM D 2467. The solvent cement used shall meet the requirements of ASTM D 2564; the joint assembly shall be made in accordance with ASTM D 2855 and the manufacturer's specific recommendations.
   2. (PVC) Plastic Pipe 4-Inch through 12-Inch Diameter: Joints shall be elastomeric-gasket as specified in AWWA C900. Jointing procedure shall be as specified for pipe less than 4-inch diameter with configuration utilizing elastomeric ring gasket.
   3. (PVC) Plastic Pipe 14-Inch through 36-Inch Diameter: Joints shall be elastomeric-gasket push-on joints made in accordance with AWWA M23.

D. Torque Wrench Test on Bolts for Mechanical Joints: The Contractor shall provide a torque wrench of a length which will allow testing of bolt tightening by the authorized representative. Before backfilling and pressure testing, the bolts of each joint shall be tested to a torque as recommended by the joint manufacturer.

3.5 SETTING OF VALVES AND VALVE BOXES

A. Valves and Valve Boxes: Valves and valve boxes shall be installed where shown or specified, and shall be set plumb. Valve boxes shall be centered on the valves. Boxes shall be installed over each outside gate valve unless otherwise shown. Where feasible, valves shall be located outside the area of roads and streets. Earth fill shall be carefully tamped around each valve box to a distance of 4 feet on all sides of the box, or the undisturbed trench face if less than 4 feet.

B. Valves: Valves, after delivery, shall be drained to prevent freezing and shall have the interiors cleaned of all foreign matter before installation. Stuffing boxes shall be tightened and the valve shall be fully opened and fully closed to insure that all parts are in working condition.

3.6 THRUST RESTRAINT

A. Plugs, caps, tees and bends deflecting 11-1/4 degrees or more, either vertically or horizontally, on waterlines, and fire hydrants shall be provided with thrust blocking, and/or metal tie rods and clamps or lugs, as required. Valves shall be securely anchored or shall be provided with thrust blocking to prevent movement. Thrust restraints shall be either thrust blocks or, for ductile-iron pipes, restrained joints as specified herein.

B. Thrust Blocks: 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 2,000 PSI after 28 days. Blocking shall be placed between solid ground and the hydrant or fitting to be anchored. The base and thrust bearing sides of thrust blocks shall be poured directly against undisturbed earth. The sides of thrust blocks not subject to thrust may be poured against forms. Blocking shall be placed so that the fitting joints will be accessible for repair. Steel rods and clamps shall be protected by galvanizing or by coating with bituminous paint.

C. Restrained Joints: For ductile-iron pipe, restrained joints shall be designed by the Contractor or the joint manufacturer in accordance with DIPRA-01 and manufacturer's joint instructions and recommendations. Joint restraint shall be constructed of ductile iron with follower gland, including restraining mechanism which imparts multiple wedging action against the pipe when properly installed. Restraint joint shall have a minimum 250 PSIG working pressure and shall be manufactured by EBAA Iron, Inc., MEGALUG, or equivalent.

3.7 TESTING OF WATER SYSTEMS AND FIRE PROTECTION

A. General: Where any section of a water line is provided with concrete thrust blocking for fitting or hydrants, the hydrostatic tests shall not be made until at least 5 days after installation of the concrete thrust blocking.

B. Pressure Test: After the pipe is laid, the joints completed, valves permanently installed, and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for 1 hour to a hydrostatic pressure test of 1.5 times the system maximum system operating pressure but neither less than 125 PSIG nor greater than 200 PSIG. Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, and valves shall be carefully examined during the partially open trench test. Joints showing visible leakage shall be replaced or remade as necessary. Cracked or defective pipe, joints, fittings, and valves, discovered in consequence of

this pressure test shall be removed and replaced with sound material, and the test shall be repeated until the test results are satisfactory.

3.8 DISINFECTION

A. Each section of completed water system shall be disinfected as specified herein. After pressure tests have been made, the unit to be disinfected shall be thoroughly flushed with water until all entrained dirt and mud have been removed before introducing the chlorinating material. The chlorinating material shall be either liquid chlorine, calcium hypochlorite, or sodium hypochlorite. The chlorinating material shall provide a dosage of not less than 50 PPM and shall be introduced into the water lines in an approved manner. Polyvinyl Chloride (PVC) pipe lines shall be chlorinated using only the chlorinating material in solution. In no case will the agent be introduced into the line in a dry solid state. The treated water shall be retained in the pipe long enough to destroy all non-spore-forming bacteria. The retention time shall be at least 24 hours and shall produce not less than 25 PPM of free chlorine residual throughout the line at the end of the retention period. All valves on the lines being disinfected shall be opened and closed several times during the contact period. The line shall then be flushed with clean water until the residual chlorine is reduced to less than 1.0 PPM. During the flushing period, each fire hydrant on the line shall be opened and closed several times. Water lines or distribution systems will not be accepted until a potability test by an approved water testing laboratory is made on water taken from the system and dosing will be repeated as necessary until such negative test is accomplished. Contractor shall furnish copies of final lab test reports for the water system.

3.9 SANITARY AND STORM SEWER SYSTEMS

A. Pipe Laying:
   1. Pipe shall be protected during handling against impact shocks and free fall and the pipe interior shall be free of extraneous material.
   2. Pipe laying shall proceed upgrade with the spigot ends of bell-and-spigot pipe pointing in the direction of the flow. Each pipe shall be laid accurately to the required line and grade. Pipe shall be laid and centered so that the sewer has a uniform invert. As the work progresses, the interior of the sewer shall be cleared of all superfluous materials.
   3. Before making pipe joints all surfaces of the portions of the pipe to be joined shall be clean and dry. Lubricants, primers, and adhesives shall be used as recommended by the pipe manufacturer. The joints shall then be placed, fitted, joined, and adjusted so as to provide a water tight system.
   4. For solvent cement systems, all joints shall be thoroughly coated with solvent weld material to ensure that there will be no water or air passage at the joint between the inner or outer wall of the pipe. Installations of solvent weld joint pipe and fittings shall be installed in accordance with ASTM F 402, and all required precautions shall be taken to assure adequate trench ventilation and protection for workers installing the pipe.

B. Caulked Joints: The packing material shall be well packed into the annular space so as to prevent the entrance of lead into the pipe. The remainder of the space shall be filled with molten lead that is hot enough to show a rapid change in color when stirred. Scum shall be removed before pouring. The lead shall be caulked to form a tight joint without overstraining the bell and shall have a minimum depth of 1 inch after caulking. Gasket joints shall be double seal compression type molded neoprene rubber, suitable for the class of piping being jointed.

C. Trenches and Backfill: Trenches shall be kept free of water and as dry during bedding, laying, and jointing. When work is not in progress, open ends of pipe and fittings shall be satisfactorily closed so that no water or other material will enter the pipe or fittings. After the joint is made, sufficient backfill material shall be placed along the pipe to prevent pipe movement off line or grade. Plastic pipe shall be completely covered to prevent damage from ultraviolet light.

D. Wye Branches: Wye branches shall be installed for sewer connections where indicated on the drawings. When conditions are such that the connecting pipe cannot be adequately supported on undisturbed earth or completed backfill, the pipe shall be encased in concrete backfill or supported on a concrete cradle. The installation of wye branches in an existing sewer shall be made by a method which does not damage the integrity of the existing sewer. One acceptable method shall consist of removing one pipe section, breaking off the upper half of the bell of the next lower section and half of the running bell of wye section. After placing the new section, it shall be rotated so that the broken half of the bell will be at the bottom. The two joints shall then be made with joint packing and cement mortar.

3.10 CLEANOUTS

A. The size of cleanouts shall be of the same size as the line to which it is connected, except that cleanouts need not be larger than 4". Pipe and fittings for cleanouts shall be cast iron with hub and spigot joints unless otherwise shown on the drawings. Cleanouts shall be constructed in accordance with details shown on the drawings. Iron ferrules shall be provided as shown on the drawings. Cleanout plugs shall be brass.

3.11 INSPECTION OF SEWERS

A. Sewers shall be inspected and approved before being backfilled. Thoroughly flush out before inspection. Lamp between manholes, or other points as directed, and show full bore indicating sewer is true to line and grade. Lips at joints on inside of sewer will not be permitted.

3.12 TESTING OF SANITARY SEWERS

A. Upon completion of the sewer construction, tests will be required on all sanitary sewer lines.

B. Air Test: Make air test when sewer is clean. Plug line at each manhole with pneumatic balls. Introduce low pressure air into plugged line until internal air pressure reaches 4.0 PSIG greater than average back pressure of any ground water pressure that may submerge the pipe. Allow at least two minutes for air temperature to stabilize before readings are taken and timing started. Portion being tested shall pass if it does not lose air at a rate to cause pressure to drop from 3.6 to 3.0 PSIG greater than average back pressure of any ground water that may submerge the pipe in less time than listed below:

Pipe Diameter In Inches	Minimum Allowable Minutes (3.6 - 3.0 PSIG Pressure
4	2.0
6	3.0
8	4.0
10	5.0
12	6.0

15 7.5

C. Exfiltration Test: In lieu of standard sanitary sewer air test, Contractor may make exfiltration tests on sewers. Subject pipe to hydrostatic pressure produced by head of water at depth of three feet above invert of sewer at upper manhole under test. In areas where ground water exists, head of water shall be three feet above existing water table. Maintain head of water for a period of one hour during which it is presumed that full absorption of pipe body has taken place, and thereafter for a further period of one hour for actual test of leakage. During one hour test period, measured maximum allowable rate of exfiltration for any section of sewer shall be 3.0 gallons per hour per 100 feet. In event that measurements indicate exfiltration greater than maximum allowable leakage, additional measurements shall be taken and continued until leaks are located and necessary repairs and corrective work have reduced leakage in section being tested below maximum allowed by specifications. For purpose of test, line between adjoining manholes will be considered a section and will be tested as such.

D. Infiltration Test: If ground water level is greater than three feet above invert of the upper manhole, infiltration tests may be allowed in lieu of the above tests. Allowable leakage for this test will be the same as for the exfiltration test.

E. Pumped Systems: Piping for pumped drainage systems shall be pressure tested as specified in this section for water systems at a minimum pressure equal to the system working pressure.

3.13 NATURAL GAS SYSTEM

A. Pipe Laying:
1. Lines may conform to the surface profile but should be graded as uniformly as practicable between pronounced high and low points. Pipe shall be laid on firm soil for the full length, and where the trench has been excavated below grade, either inadvertently or purposely, it shall be backfilled with suitable material and thoroughly tamped so as to provide full length bearing. Laying the pipe on blocks to produce uniform grade shall not be done. The pipe shall be clean inside before it is lowered in the trench and shall be maintained free of water, soil, and all other foreign matter that might injure or obstruct the operation of valves, regulators, burners, or other equipment. All openings to the pipe shall be closed by suitable means at all times except as the actual progress of the work may require. Stub ends and fittings installed for future connections shall be closed with plugs or caps. Minor change in line or grade of steel pipe, which can be accomplished through flexibility of the pipe without producing permanent deformation or overstressing the joints, may be made when approved. Changes in line or grade which exceed the limitations specified above shall be made with suitable fittings.
2. Install gas piping in separate trench with minimum horizontal clearance of thirty-six (36) inches from other utilities. Maintain twelve (12) inches vertical clearance at utility crossings. Maintain minimum cover to finish grade of 24 inches for steel or 30 inches for plastic piping. Snake plastic pipe laterally in trench to accommodate expansion and contraction of materials.

B. Jointing:
1. All joints in steel gas distribution system shall be made by the metal arc-welding process or oxyacetylene welding process in conformance with the American Standards Association Code B31.1, and in accordance with applicable requirements contained in Sections 22 0500 and 22 0504.

2. Joints for polyethylene natural gas piping distribution system shall be heat fusion welded or mechanical coupling installed in strict accordance with manufacturer's recommendations by qualified and certified plastic pipe installers. Foundation and bedding for plastic piping systems shall be in accordance with installation recommendations by the manufacturer.

C. Building Service Connections: Natural gas service connections to each individual building shall be made by means of an approved anodeless riser and steel pipe and fittings. All connections to buildings and service regulator piping shall be above ground, see Division 23, Section 22 1123.

3.14 TESTING OF NATURAL GAS

A. All gas piping shall be pressure tested using air, CO2, or nitrogen in accordance with the applicable codes and regulations, including Uniform Plumbing and Mechanical Code as adopted and interpreted by the City of Farmington and State of New Mexico, and NFPA No. 54. Plastic piping shall be tested in accordance with 49 CFR, Part 192.513, except that these pressure shall be at least 60 PSIG.

B. All pipe joints in piping system shall be exposed until they are tested. Piping between joints may be backfilled prior to test.

3.15 CLEANUP

A. Upon completion of the installation of all outside utilities, Contractor shall remove all surplus construction materials and debris resulting from the work.

END OF SECTION 22 6801

SECTION 22 0700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

B. The Midwest Insulation Contractors Association and Industrial Insulation Standards, Latest Edition, shall be utilized as a standard for the work provided under this specification.

C. Materials shall conform to applicable ASTM standards.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

1.3 SCOPE

A. All condensate pipe and fittings, domestic hot water pipe including soft hot water and circulating hot water, new and existing interior roof drains including roof drain bowls, New and existing interior overflow roof drains including overflow roof drain bowls, domestic cold water including non-potable water and soft cold water piping, water piping located outdoors exposed to ambient freezing conditions.

B. Equipment covering, including storage tanks, pumps, domestic hot water boiler stacks and breeching, domestic water heater stacks and breeching.

C. Underground Piping Systems.

D. Plastic Piping Systems.

1.4 FITTINGS

A. All fittings except as otherwise specified, shall be insulated with the same material and thickness as specified for the pipe.

B. Unions, flanges and valves on hot water, will not require insulation.

1.5 TESTING

A. All piping shall be tested in accordance with the applicable Specification Sections, before any insulation is applied.

PART 2 - PRODUCTS

2.1 INSULATION

A. Insulation shall be as manufactured by Owens-Corning Fiberglas, Knauf, CertainTeed, Johns Manville, or Armstrong, or equivalent, and shall be equal to that specified below. Insulation and all materials on the interior and exterior surfaces of ducts, pipes, and equipment shall have a composite fire and smoke hazard rating not exceeding: Flame spread - 25; fuel contribution - 50; smoke developed - 50, as determined in accordance with ASTM Standard E-84. All insulation materials used for valves and fittings shall have the same ratings as the pipe insulation. Information must be submitted by means of manufacturer's literature showing that the proposed materials conform to above specification without exception.

B. Fiberglass pipe insulation shall be rigid molded and non-combustible with 'K' factor of 0.23 at 75^{o}F. Jacket shall be all service (ASJ) vapor barrier jacket with white kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secured with self sealing longitudinal laps and butt strips. Johns Manville 'Micro-Lok' or equivalent.

C. Hydros Calcium Silicate insulation shall be rigid molded, non-combustible per ASTME 136, conforming to ASTM 533, asbestos-free with 'K' factor of 0.40 at 300^{o}F., maximum service temperature 1200^{o}F., compression strength (block) minimum of 200 PSI to produce 5% compression at 1-1/2" thickness. Johns Manville 'Thermo-12 Gold' or equivalent.

D. Fiberglass rigid board insulation for equipment shall conform to ASTM C612 with 'K' factor of 0.23 at 75^{o}F, R=8.0 minimum, 3.0 pound per cubic foot density. Provide vapor barrier jacket (FSK) with aluminum foil reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure sensitive tape and outward clinched expanded staples and vapor barrier mastic. Johns Manville 'Spin-Glas' or equivalent.

E. Elastomeric foam insulation for piping and equipment shall be flexible, cellular, molded or sheet, conforming to ASTM C534, with 'K' factor of 0.28 at 75^{o}F., maximum service temperature of 220^{o}F., maximum flame spread rating of 25 and maximum smoke development rating of 50 (3/4" thickness and less). Connections shall be made using manufacturer's approved waterproof vapor barrier retarder adhesive. Provide outdoor UV protective coating on all insulation exposed to ambient conditions.

2.2 FITTINGS

A. Valves and fittings, where required to be insulated, shall be covered with the same insulation material and thickness as specified for the pipe insulation and finished with PVC covers.

B. Valves and fittings with systems specified to be covered with metal or canvas, or polyvinyl chloride (PVC) jacket shall be covered with material to match piping system jacketing.

C. Polyvinyl chloride (PVC) preformed fitting covers with fiberglass inserts shall be used on valves and fittings, except where metal or canvas jacket is required for piping system. PVC fitting covers shall be Zeston 2000 or equivalent, gloss white and shall have a composite fire and smoke hazard rating not exceeding; flame spread - 25; smoke development - 50. Connections shall be made using tacks and pressure sensitive color matching vinyl tape. Seams shall be on the bottom side of pipe and fittings.

2.3 METAL JACKETING

A. Metal jacket shall be 0.010-inch smooth Type 304 stainless steel, smooth. [Provide moisture barrier lining for service temperatures 60°F and less, except where applied over insulation with All Service (ASJ) vapor barrier jacket. Stainless steel jacket shall be installed where specified herein or otherwise indicated on the drawings.

2.4 PVC JACKETING

A. PVC jacketing shall be Zeston 2000 or equivalent, gloss white, 0.020 inch thickness, minimum, and shall have a composite fire and smoke hazard rating not exceeding; flame spread -25; smoke development -50. Connection shall be made using tacks and pressure sensitive color matching vinyl tape. Seams shall be on the bottom side of pipe and fittings.

2.5 CANVAS JACKETING

A. Canvas jacketing shall be UL listed fabric, six ounce per square yard, plain weave cotton, treated with fire retardant lagging adhesive.

2.6 PIPE HANGERS AND SUPPORTS

A. See Specification Section 22 0504 for requirements associated with hangers and supports for piping systems.

B. All insulated piping systems shall be provided with individual hangers sized to encircle the insulation. Hangers for domestic cold water and roof drains may be installed under the insulation, provided that the vapor barrier system for cold piping and the hanger rods are protected from the formation of condensation by application of a heavy coating of vapor barrier mastic material.

C. Insulated piping supported by means of trapeze hangers or roller type hangers shall not rest directly on the hanger or support.

D. The insulation at hangers, trapezes and supports shall be protected by means of galvanized steel insulation half diameter support shields. Provide insulation insert between support shield and piping for piping size 1-1/2" and larger. Insulation inserts shall be heavy density calcium silicate molded insulation. Insulation inserts shall be the following minimum lengths. Factory fabricated thermal pipe shield as manufactured by Pipe Shields, Inc., and specified in Section 22 0504, may be used at Contractor's option.

Pipe Size, In.	Insert Length
1-1/2" to 2-1/2"	10" Long
3" to 6"	12" Long
8" to 10"	16" Long
12" and larger	22" Long

2.7 PIPE SLEEVES

A. See Specification Section 22 0504 for requirements associated with pipe sleeves for piping penetrations for building walls and frames.

B. Pipe sleeves shall be provided at penetrations through concrete and masonry construction and at fire rated and smoke rated walls and penetrations when required to comply with UL approved penetration assembly. Insulated piping passing through fire walls and smoke walls shall be provided with UL approved fire safing insulation to match the required insulation thickness and the space between the piping penetration and the adjacent wall construction shall be sealed air tight with UL approved fireproof caulking material. Pipe penetration arrangement and installation requirements shall match the applicable UL approved penetration assembly details.

PART 3 - EXECUTION

3.1 DOMESTIC HOT WATER PIPING

A. Domestic hot water pipingwith operating temperatures of 140^{o}F and less, including soft hot water and recirculating hot water piping shall be insulated with 1-inch thick fiberglass preformed pipe insulation with All Service Jacket (ASJ). Fittings shall be finished with PVC fitting covers.

B. Insulation thickness for domestic and service water systems operating in excess of 140^{o}F, shall be 1-inch thick fiberglass preformed pipe insulation with All Service Jacket (ASJ) for piping 3/4" through 3" size and 1-1/2" thick for piping 4" and larger. Fittings shall be finished with PVC fitting covers.

C. All voids formed by support saddles or other mounting or support hardware shall be filled with insulation.

3.2 DOMESTIC COLD WATER AND ROOF DRAINS

A. Domestic cold water piping including soft cold water piping and non-potable water piping shall be insulated with 1-inch thick fiberglass preformed pipe insulation with All Services Jacket (ASJ). Fittings shall be finished with PVC fitting covers.

B. Roof drain bowls and horizontal roof drain piping (new & existing) shall be insulated with 1-inch thick fiberglass insulation as specified for domestic cold water piping.

C. Overflow roof drain bowls and horizontal overflow roof drain piping (new & existing) shall be insulated with 1-inch thick fiberglass insulation as specified for domestic cold water piping.

D. All voids formed by support saddles or other mounting or support hardware shall be filled with insulation.

3.3 HANDICAP LAVATORY AND SINKS

A. Domestic hot and cold water piping and P-traps exposed below handicapped lavatories and sinks shall be insulated with HANDI LAV-GUARD insulation kits which satisfy ANSI A117.1 requirements. Insulation shall have a flexible vinyl finish which protects against burning and cushions impact.

B. Countertop sinks indicated within the Architectural drawings to be handicap-compliant shall have an off-centered drain opening and a maximum sink depth of 7-inches.

3.4 PLASTIC PIPING SYSTEMS

A. Plastic piping systems, including polypropylene acid waste, vent piping and PVC piping, installed within building return air plenums shall be insulated with 1/2" thick fiberglass preformed pipe insulation with All Service Jacket (ASJ). Fittings shall be insulated with preformed insulation fittings or, where preformed fittings are unavailable, neatly insulated with fiberglass duct wrap with white vinyl jacket.]

B. [All voids formed by support saddles or other mounting or support hardware shall be filled with insulation.

3.5 SUCTION DIFFUSERS AND PUMP IMPELLER HOUSING

A. Suction diffusers and pump impeller housing on plumbing domestic hot water pumps except fractional horsepower hot water recirculating pump located at domestic water heaters and boilers shall be insulated with minimum 1-1/2" thickness fiberglass board with vapor barrier jacket and cover with metal jacket. Fill voids in fiberglass board housing with fiberglass batt insulation. Insulation housing shall be removable for pump maintenance without damaging the insulation **and provide removable access cover for suction diffuser strainer casing cover**.

3.6 METAL JACKETING

A. Metal jacketing shall be installed on all field insulated plumbing equipment and on plumbing piping systems exposed within the mechanical equipment spaces, that are installed exposed below 8 feet above the floor, and where noted on the drawings.

B. The jacketing shall be applied with joints overlapped 2" and located to shed water. Joints and seams shall be caulked with an approved weatherproof caulking when located outdoors. The insulation shall be banded 12" on centers or screwed in place 3" on centers.

C. Fittings and valves shall have insulation covered with metal jacket, as specified herein. Fittings and valves on exterior piping and ductwork shall be covered with metal jacketing to match pipe and duct covers.

3.7 PVC JACKETING

A. PVC jacketing shall be installed on all field insulated plumbing equipment and on all piping systems exposed within the mechanical equipment spaces, where exposed to physical damage, and where noted on the drawings and specifications, except where metal or canvas jacketing is required.

B. Jacketing shall be secured in place in an approved manner by means of tacks and pressure sensitive tape.

C. Fittings and valves shall have insulation covered with PVC pre-molded PVC fittings to match jacketing, as specified below.

D. PVC jacketing shall not be permitted for use on exterior piping systems.

3.8 CANVAS JACKETING

A. Canvas jacketing shall be installed on all field insulated plumbing equipment and on all piping systems where noted on the drawings and specifications, except where metal or PVC jacketing is required.

B. Canvas jacket shall be adhered in place with fire retardant lagging adhesive and coating, to form a wrinkle free smooth continuous surface.

3.9 TERMINATION OF INSULATION

A. The termination of all insulation on pipes, at uninsulated valve connections, or unions, flexible connections, etc., shall be beveled and finished.

3.10 FACTORY INSULATED EQUIPMENT

A. Domestic water boilers, storage tanks, domestic1water heaters and other equipment as specified in the equipment schedules on the drawings shall be factory insulated.

3.11 VICTAULIC COUPLINGS

A. Where Victaulic type couplings or similar piping systems are used, all couplings shall be insulated with insulation materials and thickness equal to the piping system. Insulation of couplings shall be as specified herein for fittings.

3.12 BOILER STACKS AND BREACHING

A. Domestic hot water boiler and water heater stacks and breaching except for UL Approved, Type B heating and double wall venting systems, shall be insulated with 4" thick calcium silicate as specified in Paragraph 2.1.C and finished with metal jacketing.

3.13 VESSELS, TANKS, AND EQUIPMENT

A. Insulate hot vessels, tank, and equipment, including storage tanks etc., with 1" thickness, 3 pound density fiberglass insulation for surface temperatures from 40°F to 60°F, 2" thickness, 3 pound density fiberglass insulation for surface temperatures from 60°F to 400°F, and 4" thickness, calcium silicate insulation for surface temperatures in excess of 400°F to 1200°F. Insulation board shall be scored, beveled, or mitered to provide tight joints and shall be secured in place by mechanical pin and clip fasteners and insulation bonding adhesive applied to underside surfaces or with bands. All joints, cracks, seams and voids shall be filled with insulation bedding compound and finished to smooth surface, provide corner beads to protect edges of insulation. Cover insulation with metal jacket as specified herein. Bevel insulation away from all flanges, nameplates, and access fittings. Provide removable and re-usable insulation cover for all access fittings and manhole covers.

3.14 HEAT TRACED PIPING

A. All piping installed outdoors subject to freezing which is provided with heat tracing system as specified in Section 22 0505, including domestic water piping exposed to freezing conditions, make-up water piping to Division 22 and Division 23 equipment including valves and fittings, shall be insulated with fiberglass sectional pipe insulation, as specified for chilled water piping, and finished with metal jacket. Oversize insulation as required to accommodate electric heat tracing system. Waterproof metal jacket joints and seams with silicone caulking.

3.15 UNDERGROUND PIPING

A. Underground domestic hot water piping shall be insulated using pre-insulated piping and protective covering suitable for underground use or field insulated with a minimum of 2" thick spray-on urethane insulation, with waterproof coating.

END OF SECTION 22 0700

SECTION 22 1100 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with the applicable provisions of the General Conditions, Supplemental General Conditions, and the General Requirements.

B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.

1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.

2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead. Solder shall be 95/5 tin antimony, alloy Sb5, conforming to FS QQ-S-571 and NSF 61.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 0505, Piping Specialties for Plumbing.

D. Section 22 0523, Valves for Plumbing.

E. Section 22 0700, Plumbing Insulation.

F. Section 22 6801, Onsite Utilities, Plumbing.

G. Section 23 0900, Facility Management System.

H. Section 22 6801 for Outside Utilities.

1.3 SCOPE

A. A complete domestic cold water, hot water, recirculating hot water, soft water, and make-up water system including water heaters, pumps, thermal expansion tanks, water softeners, meters, backflow protection, shock absorbers, and associated miscellaneous accessories. This section shall include all work within the building to a point approximately 5'-0" outside the building, or as otherwise indicated.

B. Coordinate with Division 33 for site utility drawings and specifications.

PART 2 - PRODUCTS

2.1 PIPING

A. Domestic water piping including soft water piping, non-potable water piping, below grade or slab-on-grade shall be Type L soft copper, ASTM B88. Copper piping 2" and smaller shall be soft tubing and 2-1/2" thru 4" shall be either soft tubing or hard pipe. Domestic water piping 6" and larger below grade within the building and to a point approximately 5'-0" from the building shall be ductile iron pressure pipe, minimum 150 PSIG working pressure with mechanical joints. Wrap all underground copper pipe and fittings with minimum 20 mil polyethylene with minimum 50% overlay, provide for taping.

B. Domestic water piping including soft water piping above grade within the building 4" and smaller shall be Type L hard drawn copper, ASTM B88. Domestic water piping including soft water piping larger than 4" shall be copper as specified herein.

C. Proper insulating fittings, as specified in Section 22 0504, shall be installed to prevent electrolytic action between steel and copper piping connections.

2.2 FITTINGS

A. Fittings for copper piping shall be wrought copper or cast brass conforming to ANSI B16.22 and B16.23, with 95-5 solder joints, as specified in Section 22 0504.

B. Mechanically formed tee connections and couplings for copper piping system as specified in Section 22 0504, may be utilized where approved.

C. Fittings for galvanized steel pipe shall be screwed Class 150, standard galvanized malleable iron conforming to ANSI B16.3.

D. Fittings for ductile iron pipe shall be flanged or mechanical joint conforming to ANSI/AWWA C110 and C111, Class 250 minimum, cement lined, with bituminous coating.

2.3 FLANGES

A. Flanges for copper piping systems shall be Class 150 wrought copper or cast brass conforming to ANSI B16.24.

B. Flange connections for valves and equipment shall match the rating and drilling of the valves and equipment furnished.

C. Flanges for galvanized steel piping system shall be galvanized cast or malleable iron Class 125, standard threaded plain face companion flanges for flanged connections in threaded piping systems.

D. Gaskets shall be 1/16" thick ring type or full face non-asbestos material suitable for the temperatures and pressure application.

E. Flange bolting shall be carbon steel machine bolts or studs and hex nuts, ASTM A307, Grade B.

2.4 JOINTS

A. Joints in copper piping system shall be made using approved "lead-free" solder and flux as described herein and approved by all applicable codes and regulations. Surfaces to be soldered shall be cleaned bright by manual or mechanical means.

B. All joints shall be properly fluxed with a non-corrosive "lead-free" type flux manufactured to approved standards, Federal Specification QQ-S-517. Joints for copper piping systems for cold water 3" and smaller and hot water 2" and smaller shall be made using composition 95-5 tin-antimony solder. Composition 15% silver solder shall be used for all other piping sizes and for all underground joints.

2.5 SHOCK ABSORBERS

A. Furnish and install factory sealed shock absorbers conforming to Federal Specification WW-P-541 at locations shown on the drawings and/or as outlined by Plumbing Drainage Institute Standard WH-201. Josam, Precision, Jay R. Smith, Wade, Watts, Zurn or equivalent.

2.6 DOMESTIC HOT WATER GENERATING EQUIPMENT

A. Water heaters and associated auxiliary equipment shall be as specified on the equipment schedule on the drawings. Natural gas fired or electric domestic water heaters shall be as manufactured by Bock, Bradford-White, P.V.I., Ruud, or Rheem.

B. Furnish and install approved expansion tank on cold water make-up supply to hot water generating equipment as recommended by manufacturer or as shown on the drawings and specified in the plumbing equipment and fixture schedule on the drawings, Amtrol, Wilkins, or approved equal.

C. The Contractor shall provide the services of a qualified factory-trained representative to supervise hot water generation system start-up and instruct the Owner’s operating personnel for a minimum of eight (8) hours. A full one (1) year service warranty, including all parts and labor, shall be provided by the Contractor.

D. Natural gas fired domestic hot water boilers and water heater combustion flues, stack, breeching, and combustion air louvers, ducts, etc., shall be provided under Division 23.

2.7 VALVES

A. Valves other than automatic control valves are specified in Section 22 0523, Valves.

B. Automatic control valves shall be as specified in Section 23 0900, Facility Management System, except for automatic control valves furnished as a part of equipment packages, including hot water generating equipment, as specified on the equipment schedule.

2.8 PUMPS

A. Pumps shall be of the type and capacity listed in the equipment schedule. Pumps shall be selected so that the motors will not overload under any operating condition. Furnish one spare mechanical seal of each size required in conjunction with the pumps furnished under this Contract. All base mounted pumps shall have drain pans with tapped pipe connections and 3/4" drain line extended to floor drain. Pumps shall be installed so that they may be removed without the removal of the associated piping. All pumps for potable water applications shall have bronze or stainless steel body and trim.

B. Domestic water inline re-circulating pumps shall be as specified on the drawings and as manufactured by Armstrong, Bell & Gossett, Taco, Thrush, or equivalent.

2.9 WATER SOFTENER SYSTEM

A. Domestic water softener system shall be as specified in the Equipment Schedule on the drawings. The Contractor shall furnish the services of a qualified representative of the equipment manufacturer who shall provide all required start-up services, including salt, and shall provide instruction to the Owner's operating personnel in accordance with the requirements contained in Section 22 0500. Salt in sufficient quantity shall be furnished for operation of the water softener for the first one (1) month of operation of the facility after acceptance by the Owner. Manufacturer shall furnish a full two (2) year warranty, including all parts and labor for the water softener system. System shall be as manufactured by Culligan, Marlow, Pure Water Technologies, Kinetico, or approved equivalent.

2.10 WATER METER

A. Domestic water meter assembly shall be furnished by the City of Farmington. Meter size and general arrangement shall be as indicated on the drawings. The Contractor shall coordinate with the applicable representatives for the installation of the water meters and shall furnish all associated piping, valves and materials, including meter box/vault, in accordance with details on the drawings and applicable Requirements.

B. All costs, fees, and permits required for the installation of the water meter shall be secured and paid for by the Contractor unless otherwise indicated.

C. See Section 22 6801 for water meters.

D. See Section 23 0900, Facility Management System, for plumbing, meters and instrumentation.

2.11 BACKFLOW PROTECTION

A. All cross-contamination control shall be provided to ensure that no installation of the potable water supply piping system shall be made in a manner that will allow used, unclean, polluted, or contaminated water or substances to enter the domestic potable water system.

B. All backflow devices and assemblies shall be approved by the applicable Administration Authorities and shall be installed according to all applicable codes, regulations, and

manufacturer's instructions. Installation shall allow for required access and clearance for required testing, maintenance, and repair.

C. Reduced pressure backflow preventer assembly shall be furnished and installed by the Contractor. Backflow preventer size and arrangement shall be as indicated on the drawings, and shall be as manufactured by Febco, Hersey, Beeco, Watts, Wilkins, or equivalent. All costs, fees, and permits required shall be secured and paid for by the Contractor, unless otherwise indicated.

D. Section 22 6801 for backflow protection.

E. See Section 23 0504 for backflow preventer required for make-up water connections to HVAC systems.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping installation shall conform to the requirements of Section 22 0500, Common Work Requirements for Plumbing and Section 22 0504, Pipe and Pipe Fittings for Plumbing. Installation of specialties shall conform to the requirements of Section 22 0505, Piping Specialties for plumbing.

B. Insulating Fittings: Insulating unions shall be furnished and installed at all connections between dissimilar metals.

C. Valves: Each water service main, branch main and branch to a group of two or more fixtures shall be valved. Stop valves shall be as specified under fixtures.

D. Flexible Connections: If the Contractor uses a pipe material other than copper to connect to the City water main, provide mechanical joints at the connection point and also either a swing joint or expansion joint at a point 5 ft. outside the building to prevent failure of piping caused by differential settling of building and piping systems. The expansion joint material shall be suitable for domestic water usage and compatible with the sterilization chemicals.

3.2 STERILIZATION

A. All new water piping shall be charged with a chlorine solution containing not less than 50 PPM available chlorine. The solution shall remain in the piping for a period of 24 hours, during which time valves shall be opened and closed to permit a small flow of the solution. At the end of 24 hours, the solution shall be tested and must contain a residual of at least 5-10 PPM chlorine. The system shall then be drained and flushed to provide satisfactory potable water before final connection is made to the existing distribution system.

B. The Contractor shall submit a sample of the water, after sterilization and flushing for testing by an approved laboratory. A copy of the acceptable test report shall be submitted to the Owner's Representative prior to substantial completion.

3.3 BACKFLOW PROTECTION

A. Protection: All plumbing fixtures, faucets with hose connections, and all other equipment having plumbing connections shall have their water supplies protected against back-siphonage.

B. Testing: Arrange for testing backflow devices as required by the local health authorities.

3.4 TESTS

A. All water piping, hot and cold, shall be made tight under a hydrostatic test pressure of 150 lbs. per square inch and maintained without pressure loss for a minimum of four (4) hours. No caulking of joints will be permitted. Any joint found to leak under this test shall be broken, remade and a new test applied.

END OF SECTION 22 1100

SECTION 22 1123 – FACILITY NATURAL GAS SYSTEM

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions and Supplemental General Conditions.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 0505, Piping Specialties for Plumbing.

D. Section 22 0523, Valves for Plumbing.

E. Section 23 0900, Facility Management System.

F. Division 22 for onsite utilities.

1.3 SCOPE

A. Complete building natural gas piping system including meters, regulators, and miscellaneous accessories.

PART 2 - PRODUCTS

2.1 PIPING

A. Above ground pipe used for the installation, extension, alteration, and/or repair of any gas piping system shall be black steel pipe ASTM A53 Grade A or B, ERW or BW, standard wall, Schedule 40.

B. All underground gas piping shall be steel or polyethylene plastic piping as specified in Section 22 0523, Valves for Plumbing. All underground steel piping and fittings shall be protected from corrosion by approved coatings or wrapping materials as specified in Section 22 0504, Pipe and Pipe Fittings for Plumbing, and Section 22 6801, Outside Utilities, Plumbing.

2.2 FITTINGS

A. Fittings for steel piping 2" and smaller shall be either screwed or welded. Screwed fittings shall be Class 150 standard black malleable iron conforming to ANSI B16.3. Weld fittings shall be either standard weight steel butt-weld fittings conforming to ANSI B16.9, or forged steel socket-weld fittings, 2000 pound Schedule 40 conforming to ANSI B16.11.

B. Fittings for steel piping 2-1/2" and larger shall be standard weight steel butt-weld fittings conforming to ANSI B16.9.

2.3 FLANGES

A. Flanges for steel piping system shall be forged steel, weld neck, or slip-on, 1/16" raised face Class 150 flanges conforming to ANSI B16.5.

B. Flange connections for valves and equipment shall match the rating and drilling of the valves and equipment furnished.

C. Where specifically required by the application, black cast iron Class 125 standard threaded plain face companion flanges may be utilized for flanged connections in threaded piping systems.

D. Gaskets shall be 1/16" thick full face non-asbestos material suitable for the temperatures and pressure application.

E. Flange bolting shall be carbon steel machine bolts or studs and hex nuts, ASTM A307, Grade B.

2.4 VALVES

A. Valves shall be as specified in Section 22 0523, Valves for Plumbing.

B. Valves used in conjunction with gas piping shall be approved for the required service.

2.5 SEISMIC SHUT-OFF VALVE

A. Seismic earthquake actuated automatic gas shut-off valve shall automatically actuate (close) when subject to a horizontal sinusoidal oscillation having a peak acceleration of 0.3 G and a period of 0.4 seconds, or as otherwise required by the authority having jurisdiction. Valve shall not be sensitive to vibrations caused by passing trucks or accidental bumping. Valve shall provide positive sealing from -10oF to 150oF, and shall have a visual open-close indicator and manual reset. Valve shall be UL listed and FM approved, and shall be AGA, IAPMO, and State of New Mexico approved. Valves 3/4" through 1-1/2" shall be NPT connections and 2" size and larger shall be Class 125 flange connections. Valve shall be installed on downstream side of meter and regulator station in an accessible location outside the building, and shall be installed and securely supported with uni-strut brackets as recommended by the manufacturer. Valves for low pressure gas application shall have a 0.5 PSIG maximum pressure rating, and valve for high pressure gas application shall have a 20 PSIG maximum pressure rating. Valves shall be as manufactured by KOSO, Safe T Quake, SISMO, Quick Master, or equivalent.

2.6 GAS METERS

A. Natural gas meters shall be furnished and installed by the natural gas utility company, unless otherwise indicated on the drawings. All required permits and fees shall be secured and paid for by the Contractor in accordance with Section 22 0500. Gas meter shall be the type and capacity required for the application and shall be located as indicated on the drawings and in accordance with utility company requirements and applicable codes and ordinances.

B. Natural gas meters shall be furnished and installed by the Contractor in accordance with the information shown on the drawings and in the plumbing equipment and fixture schedule on the drawings.

C. See Section 23 0900, Facility Management System, for meters and instrumentation.

D. All natural gas meters shall be preceded by a main gas supply shut-off valve serviceable and accessible outside the building.

2.7 NATURAL GAS REGULATOR

A. Natural gas regulator shall be furnished and installed with the gas meter by the utility company, set for the required gas leaving pressure shown on the drawings.

B. Natural gas appliance and equipment regulators for all gas fired equipment furnished and installed under Division 23 and for natural gas fired equipment furnished by the Owner and/or under other sections of this specification shall be furnished by the equipment manufacturer or supplier and sized for the system inlet pressure and the required appliance operating pressure.

C. Natural gas regulators, as specified and shown on the drawings, shall be furnished and installed by the Contractor.

2.8 PIPING SUPPORTS

A. Natural gas piping installed on the building roof shall be supported by means of piping supports, especially designed to absorb thermal expansion and contraction of piping installed on built up and single ply membrane roofs. Wood blocks are not acceptable. Four inch and smaller gas piping shall be mounted on Erico Pyramid pipe supports or equivalent, pipe supports with a total weight not to exceed 100 pounds per pipe stand. Larger piping, and all piping requiring roller bearing action for pipe expansion, shall be mounted on Erico Pyramid RPS-H or equivalent, with a total weight not to exceed 1500 pounds per pipe collar support. Pipe support spacing shall be as recommended by manufacturer and as required by Code.

B. Piping hangers and supports shall be in accordance with Section 22 0504, Pipe and Pipe Fittings for Plumbing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping installation shall conform to the requirements of Section 22 0500, Common Work Requirements for Plumbing, and Section 22 0504, Pipe and Pipe Fittings for Plumbing. Installation of specialties shall conform to the requirements of Section 22 0505, Piping Specialties for Plumbing.

B. Installation of piping and equipment shall be in accordance with applicable codes and regulations, including Uniform Plumbing Code and Uniform Mechanical Code, and NFPA No. 54, National Fuel Gas code.

C. No gas piping shall be installed in or on the ground under any building or structure, and all exposed gas piping shall be at least 6-inches above grade. Ferrous gas piping installed underground in exterior locations shall be protected for corrosion as specified herein and in Section 22 0504, Pipe and Pipe Fittings for Plumbing.

D. Gas piping supplying the building or facility shall be provided with a shut-off valve located outside the building and readily accessible. Where gas piping supplies multiple buildings or facilities, each building shall be provided with a shut-off valve as described herein.

3.2 EQUIPMENT AND APPLIANCE CONNECTIONS

A. All gas fired equipment and appliances shall be connected to the gas piping system in an approved manner and shall be furnished with a shut-off valve installed ahead of the unit. Connections shall in no case be less than the unit inlet connection size and shall be rigidly connected, except as otherwise shown on the drawings and allowed by codes and regulations.

3.3 DRIPS

A. Accessible capped drip pockets shall be furnished at low points in piping system, connections to appliances and equipment, and other locations where condensation may tend to collect.

3.4 VENTS

A. All gas regulators and other required devices installed within the building shall be vented to the outside of the building in accordance with manufacturer's requirements, codes, and regulations.

3.5 TESTS

A. All gas piping shall be pressure tested using air, CO2, or nitrogen in accordance with the applicable codes and regulations, including Uniform Plumbing and Mechanical Code as adopted and interpreted by the City of Farmington and State of New Mexico, and NFPA No. 54.

END OF SECTION 22 1123

SECTION 22 1316 – SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions and Special Provisions.

B. Furnish and install all concrete, grout, and other required materials to fill all blockouts and/or sleeves left open for this Contractor's convenience or for the installation of this work.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 0700, Plumbing Insulation.

D. Section 22 6801 for Onsite Utilities Plumbing.

E. Section 23 0900, Facility Management System.

1.3 SCOPE

A. Complete soil, waste, and vent system, and associated miscellaneous accessories. This section shall include all work within the building to a point approximately 5' 0" outside the building, or as otherwise indicated.

B. Coordinate with Division 33 site utility drawings and specifications.

C. Plumbing equipment drains.

PART 2 - PRODUCTS

2.1 PIPING

A. Soil, waste, and vent piping below slab on grade shall be service weight cast iron no hub pipe, coated inside and outside, conforming to ASTM A-74 and 87 Standards, or polyvinyl chloride (PVC) sewer pipe, Schedule 40, conforming to ASTM D3034. Cast iron pipe and fittings shall be used on all waste piping subject to waste water temperatures that exceed 120 degrees F.

B. Soil, waste, and vent piping above grade shall be either service weight cast iron no hub pipe, coated inside and outside, conforming to ASTM A-74 and 87 standards, or polyvinyl chloride (PVC) sewer pipe, Schedule 40, conforming to ASTM D3034.

C. No-hub cast iron pipe shall conform to CISPI Standard 301 and shall be marked with CISPI Label.

D. All above and/or below ground cast iron pipe and/or fittings shall be marked with the trademark of the Cast Iron Soil Pipe Institute, or have the prior written approval of Bridgers & Paxton Consulting Engineers.

E. Piping for pumped soil and waste systems from the discharge of the sump or sewage ejector pumps to the connection to the gravity flow drainage system shall be schedule 40 galvanized steel or Type L hard drawn copper pipe for above ground installation. When underground piping is required within the building and to point approximately 5'-0" from the building perimeter, the underground piping shall be coated cast iron or ductile iron pressure pipe and fittings or PVC pipe as specified in this section with joints blocked, braced, and/or strapped in an approved manner to prevent joint separation under pressure. Underground piping located in excess of 5'-0" of the building perimeter may be PVC pressure pipe and fittings as specified in Division 33.

2.2 FITTINGS

A. Fittings for cast iron sanitary soil, waste and vent piping system shall be service weight or no-hub cast iron drainage pattern conforming to ASTM C564. Fittings shall be provided to match the required piping system.

B. Fittings for galvanized steel vent system shall be galvanized malleable iron conforming to ANSI B16.4. Fittings for galvanized steel soil and waste piping shall be galvanized drainage pattern.

2.3 JOINTS

A. Joints for cast iron pipe and fittings shall be suitable to match the required piping system and shall be either lead and oakum, double seal compression type molded neoprene gaskets conforming to ASTM C-564 Standards, and suitable for the class of pipe being jointed, with adhesive type joint lubricant, Tyler "LUBRI/FAST" or equivalent. No hub coupling shall be minimum four (4) band type with neoprene gasket material conforming to ASTM C-564, and 0.008-inch minimum, Type 304 stainless steel shear ring. Couplings shall be Tyler "Wide Body", Huskey Series 4000, Clamp-All, Mission Heavy Weight, Ideal, or equivalent.

B. Joints for galvanized steel shall be threaded, made with approved joint compound.

C. Joints for PVC piping system shall be either solvent cement type conforming to ASTM D 2855 or elastomeric seal type conforming to ASTM D 3212, except all joints above grade shall be solvent cement.

2.4 PLUMBING EQUIPMENT DRAINS

A. Equipment drain lines shall be either Schedule 40 galvanized steel pipe with galvanized malleable iron fittings or Type M copper tubing with wrought solder fittings. Provide a dielectric union at all connections between ferrous to copper materials.

2.5 DRAINS

A. Floor drains, floor sinks, and interceptors shall be Josam, Rockford, Jay R. Smith, Wade, Watts, Zurn, Mifab, or equivalent, as specified on the drawings, and compatible with the required piping systems.

2.6 TRAPS AND TAILPIECES

A. Unless otherwise specified, traps shall be copper-alloy adjustable tube type with slip joint inlet and swivel, not less than 20 gauge and without cleanout. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level and swivel joints below the discharge level, metal to metal or metal to plastic type as required for the application. Outlet shall be threaded or socket for solder joint connection as required by the application. Tailpiece shall be copper-alloy to match P-trap. Furnish cast brass wall escutcheon at waste penetration through walls. P-traps, tailpieces, escutcheon, and all piping for above floor exposed installations, including installation within cabinets and casework shall be chrome plated. Underground P-traps shall be coated cast iron as required by the application.

B. Traps and associated trim shall be furnished by the plumbing fixture manufacturer as specified in Section 22 4000 and in the Fixture Schedule on the drawings, or shall be as manufactured by Dearborn, EBC, McGuire, T & S Brass, or equivalent.

C. Traps for acid resistant piping systems shall be compatible material for required piping system.

2.7 GREASE INTERCEPTORS

A. Grease interceptors of the sizes indicated shall be of reinforced concrete, or precast concrete construction with removable three-section, 3/8-inch checker-plate cover, and shall be installed outside the building. Interceptors shall be tested and rated in accordance with Plumbing and Drainage Institute PDI-G101. Concrete shall have 3,000 PSI minimum compressive strength at 28 days.

2.8 SUMP PUMPS

A. Sump pumping systems shall be furnished and installed of the capacity and arrangement specified in the pumping fixture and equipment schedule, and detailed on the drawings. Pumps shall be submersible type, electric driven, complete with all required safety and operating control systems, including magnetic starters, disconnects, hand-off-auto control switches, pilot lights, control transformers, relays, and interlocks installed within a NEMA approved system control panel. Furnish pump water level control float type switches, field adjusted to start and stop pumps at required operating water levels, and high limit water level alarm switch for connection to remote alarm indication. For duplex pumping system arrangement, furnish automatic alternator to sequence lead/lag pumps and to start second pump if flow exceeds the capacity of the first pump. Pumps for sewage service shall be capable of passing not less than a two (2) inch diameter sphere, and discharge piping shall not be less than 2 inch size. Pump discharge piping for each pump shall be installed above the floor for service and maintenance, and the discharge piping shall be provided with a union or flange connection, a non-clog check valve, and service shut-off valve located accessibly near the pumps. Sumps shall be fiberglass or coated steel encased in concrete

with the capacity and arrangement shown on the drawings. Furnish bolted and gasketed gas tight cover with inlet, outlet, vent, and access manhole connections sized and arranged as indicated on the drawings. Aurora, Flygt, Hydro-Matic, Liberty, Weil or equivalent.

2.9 CLEANOUTS

A. Cleanouts shall be as manufactured by Zurn, Jay R. Smith, Watts, Wade, or Josam, and shall be of the same size as the pipe, except that cleanout plugs larger than 4 inches will not be required. Cleanouts installed in connection with cast iron soil pipe shall consist of a long sweep, quarter bend or one or two eighth bends extended to an easily accessible place, or as indicated on the drawings. A standard cleanout fitting, Zurn No. ZN-1400-ZB, with polished bronze top shall be caulked into the hub of the fitting and fini¬¬shed flush with the floor. Where cleanouts in connection with threaded pipe are shown and are accessible, they shall be cast iron drainage T pattern, 90 degree branch fittings with square head brass screw plugs of the same size as the pipe up to and including 4 inches. Wall cleanouts in finished areas shall be Zurn No. Z 1460 8 with polished stainless steel or chrome plated metal cover.

B. Cleanouts for acid resistant piping system shall be compatible material for the required piping system.

C. Install cover flush with grade (outside) to avoid tripping hazard.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping installation shall conform to the requirements of Section 22 0500, Common Work Requirements for plumbing, and Section 22 0504, Pipe and Pipe Fittings for Plumbing. Installation of specialties shall conform to the requirements of Section 22 0505, Piping Specialties.

B. All soil, waste, and vent piping shall be properly graded and installed in strict accordance with all applicable codes and requirements.

C. Make all changes in direction of drainage piping by use of 45 degree wyes, long turn tee wyes, long sweep quarter bends, sixth, eighth or sixteenth bends. Short turn sanitary tees permissible on horizontal to vertical where space conditions require.

3.2 FLASHINGS

A. Flashing for piping through built up roofing with lead flashing, weight of not less than four pounds per square foot, extending at least 12" in all directions under roofing and up pipe. Cap flash pipe and turn down inside 1" approximately. Run all pipes extending through roof prior to roof installation. Flashing shall be two piece type, base and cap flashing.

B. Vinyl Flashing: As an option to lead flashing in vents through roof, the Contractor may use vinyl flashing, 20 mil thickness, ASTM C689 62 tear strength, 0.14 #/Ft. equal to Pasco Manufacturing

Co., or equivalent. The flashing shall be installed in accordance with the manufacturer's recommendations.

3.3 DRAINS

A. All floor drains, and floor sinks shall be installed with grates square with building lines and with the top of grates installed level with adjacent finished floor.

B. The Contractor shall extend drain lines from all equipment requiring drainage, relief valves, and drain pans to the nearest floor drain or floor sink, and shall terminate indirectly with a minimum clearance of one (1) inch or as otherwise required by applicable codes and standards. Relief valve drain lines shall be extended to the nearest floor drain and shall be equal in size to relief valve outlet port.

3.4 TESTS

A. The sanitary soil waste and vent system and condensate drain system shall be tested by filling system with water. System shall remain filled with no loss of water for a minimum of 2 hours. The system water test shall be applied to the drainage and vent systems either in its entirety or in sections. Preliminary testing shall be accomplished as necessary prior to final test.

B. If applied to the entire system, all openings in the piping shall be tightly closed, except the highest opening, and the system filled with water to point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest opening of the section under test, and each section shall be filled with water, but no section shall be tested with less than ten (10) feet of water. In testing successive sections, at least the upper ten (10) feet of the next preceding section shall be tested, so that no joint or pipe in the building (except the uppermost ten feet) of the system shall have been submitted to a test of less than a ten (10) foot head of water. The system shall then be tight at all points.

C. Piping for pumped drainage systems shall be pressure tested as specified in Section 22 1100 for water systems as a minimum pressure equal to the system working pressure.

END OF SECTION 22 1316

SECTION 22 1400 – FACILITY ROOF AND AREA DRAINAGE

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with the applicable provisions of the General Conditions and Special Provisions.

1.2 RELATED SECTIONS

A. Section 22 0500, Common Work Requirements for Plumbing.

B. Section 22 0504, Pipe and Pipe Fittings for Plumbing.

C. Section 22 0700, Plumbing Insulation.

D. Section 22 6801 for onsite plumbing utilities.

1.3 SCOPE

A. A complete roof drainage and overflow roof drainage system and associated miscellaneous accessories. This section shall include all work within the building and to a point approximately 5'-0" outside the building, or as otherwise indicated.

B. Coordinate with Division 33 site utility drawings and specifications.

PART 2 - PRODUCTS

2.1 PIPING

A. Pipe, fittings and couplings below grade or slab on grade shall be service weight cast iron no hub pipe, coated inside and outside, conforming to ASTM A-74 and 87 Standards, or polyvinyl chloride (PVC) sewer pipe Schedule 40, conforming to ASTM D3034.

B. Pipe, fittings and couplings above slab on grade shall be either service weight cast iron no hub pipe, coated inside and outside, conforming to ASTM A-74 and 87 Standards, or polyvinyl chloride (PVC) sewer pipe Schedule 40, conforming to ASTM D3034.

C. No-hub cast iron pipe shall conform to CISPI Standard 301 and shall be marked with CISPI Label.

D. All above and/or below ground cast iron pipe and/or fittings shall be marked with the trademark of the Cast Iron Soil Pipe Institute, or have the prior written approval of Bridgers & Paxton Consulting Engineers.

2.2 FITTINGS

A. Fittings for cast iron pipe shall be service weight or no-hub cast iron drainage pattern, conforming to ASTM C564, coated for underground installation.

B. Fittings for galvanized steel pipe shall be screwed galvanized cast iron or malleable iron drainage pattern.

C. Fittings for PVC piping system shall be Schedule 40 drainage pattern, solvent cement type conforming to ASTM B 2855 or elastomeric seal type conforming to ASTM D 3212.

2.3 JOINTS

A. Joints for cast iron pipe and fittings shall be suitable to match the required piping system and shall be either lead and oakum, or double seal compression type molded neoprene gaskets conforming to ASTM C-564 Standards, and suitable for the class of pipe being jointed, with adhesive type joint lubricant, Tyler "LUBRI/FAST" or equivalent. No-hub couplings shall be minimum four (4) band type with neoprene gasket material, conforming to ASTM 564, and 0.008-inch minimum, Type 304 stainless steel shear ring. Couplings shall be Tyler "Wide Body," Husky Series 4000, Clamp-All, Mission Heavy Weight, Ideal, or equivalent.

B. Joints for galvanized steel shall be threaded, made with approved joint compound.

C. Joints for PVC piping system shall be either solvent cement type conforming to ASTM D 2855 or elastomeric seal type conforming to ASTM D 3212, except all joints above grade shall be solvent cement.

2.4 DRAINS

A. Roof drains, overflow roof drains, shall be Josam, J. R. Smith, Watts, Wade, Zurn, Froet, Mifab, or equivalent as specified on the drawings and compatible with the required piping system. Drains shall be suitable for the required building construction system and shall be furnished complete with all extensions, receptors, flashings, and accessories required for the complete water proof installation.

2.5 CLEANOUTS

A. Cleanouts shall be as manufactured by Josam, J. R. Smith, Wade, Watts, Zurn, Mifab, or equivalent, and shall be of the same size as the pipe, except that cleanout plugs larger than 4 inches will not be required. Cleanouts installed in connection with cast iron soil pipe shall consist of a long sweep, quarter bend or one or two eighth bends extended to an easily accessible place, or as indicated on the drawings. A standard cleanout fitting, Zurn No. ZN-1400-ZB, with polished bronze top shall be caulked into the hub of the fitting and fini¬-shed flush with the floor. Where cleanouts in connection with threaded pipe are shown and are accessible, they shall be cast iron drainage T pattern, 90 degree branch fittings with square head brass screw plugs of the same size as the pipe up to and including 4 inches. Wall cleanouts in finished areas shall be Zurn No. Z 1460 8 with polished stainless steel or chrome plated metal cover.

2.6 ACCESSORIES

A. Refer to Section 22 1316, Sanitary Waste & Vent Piping, for roof flashing requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping installation shall conform to the requirements of Section 22 0500, Common Work Requirements for Plumbing, and Section 22 0504, Pipe and Pipe Fittings for plumbing. Installation of specialties shall conform to the requirements of Section 22 0505, Piping Specialties for Plumbing.

B. Roof drainage piping shall be properly graded and installed in strict accordance with all applicable codes and requirements. All turns and fittings shall be supported same as for waste and vent piping as specified in Section 22 1300.

3.2 PVC PIPING SYSTEMS

A. Installation of PVC piping systems within the building shall be in accordance with all applicable plumbing and building codes and ordinances. No exposed piping or fittings shall be installed within the building return air plenums unless the material complies with all code requirements, including required fire and smoke ratings, or is properly protected in a manner approved by the administration authority. Penetrations of fire rated barriers shall be provided with cast iron as specified in this section, or as otherwise approved and accepted by the applicable code authority. Piping above grade shall be installed with uniform slope and shall be properly supported to avoid sagging or bending of horizontal or vertical lines due to insufficient support or thermal expansion/contraction. All piping shall be supported and installed in strict accordance with manufacturer's recommendations.

B. PVC pipe and fittings exposed within building return air plenums shall be covered with an approved insulation material, as specified in Section 22 0700.

3.3 TESTS

A. The roof drainage system shall be tested by filling system with water. System shall remain filled with no loss of water for a minimum of 2 hours. The system water test shall be applied to the systems either in its entirety or in sections. Preliminary testing shall be accomplished as necessary prior to final test.

B. If applied to the entire system, all openings in the piping shall be tightly closed, except the highest opening, and the system filled with water to point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest opening of the section under test, and each section shall be filled with water, but no section shall be tested with less than a ten (10) foot of water. In testing successive sections, at least the upper ten (10) feet of the next preceding section shall be tested, so that no joint or pipe in the building (except the uppermost ten feet) of

the system shall have been submitted to a test of less than a ten (10) foot head of water. The system shall then be tight at all points.

END OF SECTION 22 1400

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Division 23 –

HVAC

SECTION 23 0500 - COMMON WORK REQUIREMENTS FOR HVAC

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. See General Conditions and Supplementary Conditions.

B. The requirements listed under General Conditions and Supplementary Conditions and the General Requirements are applicable to this section and all subsequent sections of Division 23 and form a part of the contract.

C. See Division 1 for requirement of Testing, Adjusting and Balancing of Mechanical Systems and Commissioning for Mechanical Systems.

D. See Division 21 for Fire Suppression Systems.

E. See Division 22 for Plumbing Systems.

F. See Division 26 for Electrical Systems.

G. See Division 28 for Fire Alarm Systems.

H. All electrical work, regardless of voltage which is provided under Division 23 shall comply with the requirements of the National Electric Code (NEC) and Division 26.

1.2 HEATING, VENTILATING & AIR CONDITIONING (HVAC) DIVISION INDEX

Section 23 0500	Common Work Requirements for HVAC
Section 23 0501	Demolition
Section 23 0504	Pipe and Pipe Fittings
Section 23 0505	Piping Specialties
Section 23 0523	Valves
Section 23 0549	HVAC and Electrical Installation Coordination
Section 23 0550	Variable Frequency Drives
Section 23 0593	Testing, Adjusting and Balancing
Section 23 0700	Mechanical Systems Insulation
Section 23 0810	Performance Assurance Contractor of HVAC Systems
Section 23 0900	Facility Management System (FMS)
Section 23 2113	Heating Water System & Equipment
Section 23 2123	Pumps
Section 23 2313	Refrigerant Piping System & Equipment

Section 23 3000	Air Tempering System and Equipment
Section 23 3423	HVAC Power Ventilators
Section 23 3713	Diffusers, Registers & Grilles
Section 23 3813	Kitchen Exhaust and Makeup Air Systems
Section 23 5216	Condensing Boilers
Section 23 7313	Modular Multizone indoor Central-Station Air Handling Units

1.3 CODES AND PERMITS

A. The HVAC work shall be performed in strict accordance with the applicable provisions of the International Building Code, 2021 Edition**;** the Uniform Plumbing Code, 2021; the Uniform Mechanical Code, 2021 Edition and the International Fire Code, 2021 Edition as adopted and interpreted by the State of New Mexico, City of Farmington, and the National Fire Protection Association (NFPA Regulations), current adopted edition, regarding fire protection, heating and ventilating and air conditioning systems and electrical systems. All materials and labor necessary to comply with rules, regulations and ordinances shall be provided. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. The Contractor shall hold and save the Architect free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

B. Permits necessary for performance of the work shall be secured and paid for by the Contractor.

C. The following lists some applicable codes and standards that shall be followed.

Applicable county and state mechanical, electrical, gas, plumbing, health and sanitary codes, laws and ordinances.

National Electrical Manufacturer's Association Standards

National Electrical Code

Underwriters Laboratories, Inc. Standards

American National Standards Institute

American Society for Testing Materials Standards

Standards and requirements of local utility companies.

National Fire Protection Association Standards

American Society of Mechanical Engineers Boiler and Pressure Vessel Codes

Occupational Safety and Health Act

Commercial and Industrial Insulation Standards (MICA)

American Gas Association

Applicable publications of Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA)

The American Society of Sanitary Engineering

1.4 RECORD DRAWINGS

A. See Division 1, for requirements associated with Project Record Drawings.

B. The Contractor shall be responsible to maintain a complete and accurate set of marked up blue-line prints showing information on the installed location and arrangement of all mechanical work, and in particular, where changes were made during construction. The Contractor shall be responsible for keeping record drawings accurate and up-to-date throughout the construction period. Record drawings may be reviewed and checked by the Architect during the construction and in conjunction with review and approval of monthly pay requests. Contractor shall include copies of all addenda, RFI's, bulletins, and change orders neatly taped or attached to record drawing set.

C. After installation and acceptance of direct buried underground piping and service lines in trenches, the Contractor shall take 'as-built' measurements, including all depths, prior to commencement of backfilling operations. It will not be sufficient to check off line locations. Definite measurements shall be taken for each service line. The location of buried piping and trench service lines shall be shown on the drawings and dimensioned from fixed points.

1.5 QUALIFICATIONS

A. All mechanics shall be skilled in their respective trade.

B. All welders shall be certified in accordance with the ASME Boiler Test Code, Section IX, latest issue.

1.6 QUALIFICATION PROCEDURES

A. The storage, handling, and transportation of all refrigerants, oils, lubricants, etc. shall be accomplished in strict compliance with all State, local, and Federal Regulations including all requirements set forth by the Environmental Protection Agency (EPA) for the safe handling of regulated refrigerants and materials. The Contractor shall utilize qualified and/or certified personnel and equipment as prescribed by these requirements. In no situation shall any refrigerant be discharged to the atmosphere.

1.7 HAZARDOUS CONDITIONS

A. Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operation personnel, shall be cut back and/or protected to reduce the risk of injury.

1.8 HAZARD SIGNS

A. Equipment rooms, fan plenums, and similar areas containing moving or rotating parts, or other potentially hazardous environments shall include signs on all doors entering such spaces that shall read similar to the following: "Hazardous Area - Authorized Personnel Only."

B. Confined Spaces: Areas designated by OSHA Standard 1910.146 as a confined space shall be marked with a sign that reads "Confined Space - Entry by authorized personnel only, by permit."

1. "Confined Space" means a space that:

   a. Is large enough and so configured that an employee can bodily enter and perform assigned work; and

   b. Has limited or restricted means for entry or exit (for example, tanks, vessels, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and

   c. Is not designed for continuous employee occupancy.

C. The Contractor shall survey the final premises to determine where any such potentially hazardous areas exist. If the Contractor feels that hazards exist which cannot be suitably provided for through the above typical methods, he shall forward in writing his concerns, and request for a decision concerning the referenced hazard, prior to the final inspection of the facilities.

1.9 SUBMITTALS

A. The Contractor shall submit submittal brochures of all equipment, fixtures and materials to be furnished under Division 23, including but not limited to the following:

   1. Piping materials, valves, insulation materials and installation methods, vibration isolation devices, pipe penetration installation methods and products for fire rated assemblies, fans, pumps, duct materials, and all equipment listed on equipment schedules, and in related construction documents.

   2. Materials, certification, shop drawings, and other information as specified in the individual Division 23 Specification Sections within this Specification.

B. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior review or are installed in a manner which is not in conformance with the requirement of this Specification and for which the Contractor has not received a written review, removal of all the unauthorized materials and installation of those indicated or specified shall be provided at no change in contract amount.

C. All equipment shall be installed in accordance with the manufacturer's recommendations. Provide all accessories and components for optimum operation as recommended by the manufacturer.

D. Expense: All costs for the preparation, correction, delivery, and return of the submittals shall be borne by the Contractor.

E. Submittals and one resubmittal will be reviewed by the Architect/Engineer. If the Contractor fails to provide the required data with his second submittal, he will be charged for the third and subsequent reviews.

F. See Division 1 for additional submission requirements.

G. The Contractor shall submit a maximum of seven (7) copies of submittal brochures for review. Brochures shall be submitted within thirty (30) days after contract award. One (1) copy of all submittals will be retained by the Engineer. The remaining copies will be returned to the Architect. Additional sets of submittals, if required by the Contractor, shall be reproduced by the Contractor from the reviewed and marked sets returned to the Contractor.

H. Complete data must be furnished showing performance, quality and dimensions. No equipment or materials shall be purchased prior to receiving written notification that submittals have been reviewed and marked either "NO EXCEPTIONS TAKEN" or "EXCEPTIONS AS NOTED." Submittals returned marked "EXCEPTIONS AS NOTED" do not require resubmittal provided that the Contractor agrees to comply with all exceptions noted in the submittal, and so states in a letter.

I. Review of Submittals: Submittals will be reviewed with reasonable promptness, but only for conformance with the design concept of the Project and for conformance with the information indicated on the Drawings and stated in the Specifications. Review of a separate item as such will not indicate review of the assembly in which the item functions. Review of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents, nor for errors or omissions in the submittals; or for the accuracy of dimensions and quantities, the adequacy of connections, and the proper and acceptable fitting, execution, functioning and completion of the work. Review shall not relieve the Contractor of responsibility for the equipment fitting within the allotted space shown on the drawings with all clearances required for equipment operation, service and maintenance including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC). Any relocation of mechanical and/or electrical equipment, materials and systems required to comply with minimum clearances shall be provided by the Contractor without additional cost under the Contract.

J. Shop drawings will be returned unchecked unless the following information is included: cover sheet shall be provided for each submittal of equipment, products and material proposed for use on the project. A common cover sheet for similar equipment (example: all roof top units or all fire protection products) is acceptable. The cover sheet shall list equipment by symbol number; reference all pertinent data in the Specifications or on the drawings; provide size and characteristics of the equipment, name of the project and a space large enough to accept a review stamp. The data submitted shall reflect the actual equipment performance under the specified conditions and shall not be a copy of the scheduled data on the drawings. Cover sheet shall clearly identify any deviations from the specifications for submitted equipment, products, and materials.

K. Use of substitutions reviewed and checked by the Engineer does not relieve the Contractor from compliance with the Contract Documents. Contractor shall bear all extra expense resulting from the use of any substitutions where substitutions affect adjoining or related work required in this Division or other Divisions of this Specification.

L. If Contractor substitutes equipment for that drawn to scale on the drawings, he shall prepare a 1/4" = 1'-0" installation drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, and including piping, and electrical equipment requirements, to verify that equipment will fit space with adequate clearances for maintenance. This 1/4" = 1'-0" fabrication drawing shall be submitted for review with the shop drawing submittals of the substitution. Failure to comply with this requirement will result in the shop drawings being returned unchecked.

1.10 COORDINATION DRAWINGS

A. The Contractor shall, in advance of the work, prepare coordination drawings for:

1. Mechanical equipment rooms, and other spaces housing air handlers units, fans, pumps and refrigeration equipment, etc.

2. Piping and chases.

3. Complete supply, return, and exhaust ductwork, HVAC piping, located within the building.

4. Layout of all HVAC equipment.

B. Show the location of ductwork and piping openings through the building floors, walls and roofs coordinated with Architectural, Structural and Electrical, as well as the location and elevations of building HVAC equipment and systems, including piping and ductwork, coordinated with plumbing, fire suppression and electrical systems. Coordination drawings, including plans, elevations and sections, as appropriate, shall clearly show the manner in which the HVAC systems fit into the available space and coordinates with fire suppression and plumbing equipment, piping, sprinkler heads, and electrical equipment, including conduits, light fixtures, motor control centers, transformers, panels, variable frequency drives, etc. Drawings shall demonstrate required code clearances for mechanical and electrical equipments, control panels, etc., and proper operation, maintenance and replacement of HVAC devices and equipment. Coordination drawings shall be of appropriate scale to satisfy the previously stated purposes, but not smaller than 1/8 inch scale for floor plans and 1/4 scale of equipment rooms and chase areas. Drawings may be composite or may be separate but fully coordinated drawings of the same scale. Every subcontractor must sign-off on coordination drawings prepared by each craft. Failure to sign-off will indicate that subcontractor is proceeding at his own risk. Any cost required to relocate systems to comply with required clearance and equipment installation requirements shall be provided by the Contractor without additional cost under the contract.

C. Seven (7) complete sets of coordination drawings shall be submitted prior to the scheduled start of the work in the area illustrated by the drawings, for the purpose of showing the Contractor's planned method of installation. The objectives of such drawings are to promote carefully planned work sequence and proper coordination, in order to assure the expeditious solutions of problems, and the installation of lines and equipment as contemplated by the contract documents while avoiding or minimizing additional costs to the Contractor and to the Owner.

D. In the event the Contractor, in coordinating the various installations and in planning the method of installation, finds a conflict in location or elevation of any of the mechanical systems, with the structural items or with other construction items, such conflicts shall immediately be documented and submitted for clarification. In doing so, the Contractor shall explain the proposed method of solving the problem, or shall request instructions as to how to proceed if adjustments beyond those of usual trades coordination are necessary.

E. Installation of HVAC work shall not proceed prior to the submission and completion of the review of the coordination drawings, and any conflicts which are disclosed by the coordination drawings. It is the responsibility of the Contractor to submit the required drawings in a timely manner consistent with the requirements for completing the work covered by this contract within the prescribed contract time.

1.11 DOCUMENTED 3D COORDINATION EFFORT SUBMITTAL

A. All requirements noted in individual specification sections for submittal of coordination drawings and shop drawings shall be strictly followed. Equipment fabrication and installation that occur prior to the approval of these drawings shall be subject to removal and replacement at no additional cost to the owner.

B. In addition to the required drawings noted above, contractor shall prepare 3D Coordination drawings for the systems noted below. The intent of this 3D Coordination is to determine conflicts and coordinate solutions that will resolve final system installation. The contractor may use the overall 3D model to generate the coordination drawings and vice-versa.

1. HVAC

2. Plumbing

3. Electrical

4. Fire Protection

5. Special Systems

6. Structural

C. After shop drawings are reviewed, incorporate any review comments and then participate in a formal and documented coordination effort with the contractors and subcontractors for other divisions of the work. Show all piping systems and equipment on the ductwork drawings, and send file(s) to the General Contractor and the subcontractors for plumbing, fire protection, electrical, and other disciplines.

D. Make full-size plots of the drawings. Participate in meetings with the GC and other subcontractors to review each area, identify conflicts, and resolve conflicts. Submit the resolutions to the Engineer for review. Maintain adequate space for operation, maintenance, and code-required clearances. Ensure that all subcontractors initial each plan to indicate that they have participated in the coordination effort.

1.12 PRIOR APPROVAL

A. See Division 1 for additional substitutions and product options requirements.

B. Identification of Division 23 equipment, and materials listed within this specification and in the Equipment Schedules on the drawings, which are identified by Manufacturer's Name, Trade Name, and/or Model Numbers are generally not meant to give preference to any manufacturer, but are provided to establish the design requirements and standards. Additional manufacturers judged to be "equivalent" to the specified product may also be listed.

C. Requests for proposed substitutions shall be accompanied with catalog and technical data. Actual equipment components and options shall be highlighted and any discrepancies with the specified equipment noted. Only the following equipment requires prior approval:

Boilers
Air Handling Units
Centrifugal Fans
Pumps
Utility Sets
Vibration Isolators
Water Treatment Systems
Terminal Units

DX Split Systems

D. Requests for proposed substitutions for unspecified Division 23 major items of equipment, and materials shall be submitted by the manufacturer, supplier, and/or sub-contractor for review. Two (2) copies of Division 23 prior approval requests shall be submitted and received not later than ten (10) calendar days prior to the bid date in accordance with Division 1 requirements.

E. One (1) copy of prior approval submittal data shall be sent to the Architect with the second copy sent directly to the Engineer.

F. Requests for prior approval received after the specified due date may not be considered.

G. Division 23 prior approval equipment and materials which are submitted as specified herein and accepted will be included in an Addendum. Equipment, and materials which are accepted under this prior approval process are accepted for bidding purposes only, subject to all requirements, terms, and conditions of the Contract Documents, including the Submittal Section contained herein.

H. Division 23 prior approval substitution requests shall be submitted utilizing the *Division 23 Substitution Request Form* included at the end of this section.

1.13 GUARANTEE-WARRANTY

A. See Division 1 for warranties.

B. The following guarantee is a part of the specifications and shall be binding on the Contractor:
"The Contractor guarantees that this installation is free from mechanical defects. He agrees to replace or repair any part of the installation which may fail within a period of one year after date established below, provided that such failure is due to defects in the materials or workmanship or to failure to follow the specifications and drawings. Warranty of the Contractor-furnished equipment or systems shall begin on the date the system or equipment is placed in operation for beneficial use of the Owner or occupancy by the Owner, whichever occurs first; such date will be determined in writing, by means of issuing a 'Certificate of Substantial Completion', AIA Form G704," or equivalent.

C. The extent of guarantees or warranties by Equipment and/or Materials Manufacturers shall not diminish the requirements of the Contractor's guarantee-warranty to the Owner.

D. All items of HVAC equipment shall be provided with a full one (1) year parts and labor warranty, from the date of acceptance by the Owner.

PART 2 - PRODUCTS

2.1 QUALITY OF MATERIALS

A. All equipment and materials shall be new, and shall be the standard product of manufacturers regularly engaged in the production of heating, ventilating and air conditioning equipment and shall be the manufacturer's latest design. Specific equipment, shown in schedules on drawings and specified herein, is to set forth a standard of quality and operation.

2.2 ALTITUDE RATINGS

A. Unless otherwise noted, all specified equipment capacities are for an altitude of 5000 feet above sea level and adjustments to manufacturer's ratings must be made accordingly.

2.3 ELECTRICAL SERVICES - MOTORS

A. Each motor, unless otherwise specified of 3/4 HP and greater, shall be designed for operation with 3 phase, 60 Hz, 460 volt electrical service. Unless otherwise specified, motors of 1/2 hp and less shall be designed for operation with single phase, 60 Hz, 120 volt electrical service. Motors shall be 1750 RPM, squirrel cage, normal starting torque and normal starting current, in accordance with NEMA standards unless otherwise specified.

B. All T-frame, ODP motors 5 HP and above shall be premium efficiency motors with a minimum power factor of 0.85 on 1800 RPM motors and a minimum efficiency rating in accordance with IEEE Standard 112, Test Method 'B' as scheduled below. In addition, all motors used in conjunction with variable frequency drives shall be premium efficiency.

NEMA EFFICIENCY	
Motor Horsepower	**Efficiency, Minimum**
5	90.2
7-1/2	91.0
10	91.7
15	92.4
20	93.0
25	92.4
30	93.0
40	93.6
50	93.6
60	93.6
75	95.0
100	95.4
125 & 150	95.8

C. Motors, including premium efficiency motors shall be manufactured by General Electric Baldor, Louis Allis (Spartan), Marathon, Reliance Electric, Westinghouse, or equivalent having equal efficiencies.

D. Special motors as may be necessary by the application and as specified herein and on the drawings include C-FACE, totally enclosed fan cooled (TEFC),explosion-proof, etc., shall be provided as required and shall be furnished manufacturer's premium efficiency rating for 5 HP and larger.

E. Each motor shall be of the horsepower as specified and suitable for use at an altitude of 5000 feet. All motors shall have grease lubricated sealed ball bearings. Motors larger than 1 HP shall have a tandard grease fitting "Zerk" and a separate grease relief tapping. Motors shall be factory lubricated. Motors shall be commercially dynamically balanced and tested at the factory before shipment and shall be selected for quiet operation. Motors for V-belt drives shall be provided with a cast iron or steel base, with slide rail and adjustable belt tension screw device. The Contractor shall line up motors and drives and place motors and equipment on foundations ready for operation.

F. Unless indicated otherwise, motors shall be NEMA design B with a service factor of 1.15 with 40°C rise and total temperature rise of 65°C ambient and when powered from the system voltage feeding the motor. TEFC motors shall have a service factor of 1.00 with total temperature rise of 65°C in the above conditions. Motors located in areas exceeding 40°C in the ambient shall be factory rated for the ambient temperature of the motor environment. Single phase motors shall generally be NEMA Type N split phase induction motors with built-in thermal protectors. Unless otherwise specified for a particular application use electric motors with the following requirements.

1. Single-phase Motors: Capacitor-start type for hard starting applications. Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC).

2. Polyphase Motors: NEMA Design B, Squirrel cage, induction type. Each two speed motor shall have two separate windings.

3. Rating: Continuous duty at 100% capacity in an ambient temperature of 40°C.

G. If the Contractor proposes to furnish motors varying in horsepower and/or characteristics from those specified, he shall first submit his request for the change and shall then coordinate the change with the Division 26 Contractor and shall pay all additional charges in connection with the change.

H. The Contractor shall ensure proper coordination between motors and variable frequency drives. See Section 23 0550 also.

2.4 ELECTRICAL WIRING AND CONTROL EQUIPMENT

A. All wiring and conduit shall be furnished and installed as scheduled in Section 230549 unless otherwise noted or directed.

B. The Contractor shall coordinate completely with all trades and Sub-Contractors as required to ensure that all necessary components of control work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of such coordination.

C. The piping system may be bonded to the electrical ground bus at the electrical service equipment, but shall not under any circumstances be used as the main grounding electrode for the electrical service.

2.5 V-BELT DRIVES

A. V-belt drives shall be of fabric and rubber construction of approved manufacturer. Multiple belts shall be matched and all belts shall be adjusted to drive the apparatus properly and to prevent slippage and undue wear in starting. Unless otherwise specified in the Mechanical Equipment Schedule, drive horsepower ratings shall be 150 percent of the specified motor nameplate rating. Motor sheave shall be adjustable unless otherwise specified in the Equipment Schedule on the Drawings. Belt data (for location and size) shall be included with maintenance and O&M data.

2.6 PAINTING

A. All finish painting of HVAC systems and equipment will be under "Painting," unless equipment is hereinafter specified to be provided with factory applied finish coats.

B. All equipment shall be provided with factory applied prime finish, unless otherwise specified.

C. Touch-Up: If the factory finish on any equipment is damaged in shipment or during construction of the building, the equipment shall be refinished.

2.7 BELT AND FAN GUARDS

A. The Contractor shall provide for each V-belt drive a galvanized iron belt guard which shall be constructed around an angle iron frame, securely bolted to the floor or apparatus. The guard shall completely enclose drives and pulleys and be constructed to comply with all safety requirements. Hinged access doors not less than 6" x 6" shall be provided for access to motors and fan shaft for test purposes. Furnish wire mesh screen cover reinforced with bars or rods for double inlet fans and for all open inlets and outlets for propeller fans, installed so as not to restrict the air flow. All Zerk fittings and oil cups shall be accessible without removing belt guards. All belt guards shall be constructed in accordance with OSHA requirements.

B. All flexibly connected pumps shall be provided with protective steel coupling guards.

2.8 IDENTIFICATION OF VALVES

A. Each valve shall be provided with a stamped metal tag secured to the valve. Tag shall indicate the valve number, the service and function of each valve. Contractor shall furnish two sets of prints of drawings showing floor plan for each floor with all valves accurately located and labeled. Submitted drawings shall be neat and easily readable. In addition, the Contractor shall provide a valve chart, typed neatly on 8-1/2" x 11" sheets, listing the number, size, location, function, normal operating position, on each valve installed under Division 23. Valves shall be listed by system, i.e. domestic cold water, hot water, chilled water etc. Tags shall be stamped brass 1-1/2" diameter, and secured to valves by heavy copper figure eight hooks, braided stainless steel wire anchor, or other approved means.

B. Division 23 valve tags shall be coordinated with Division 22 and Division 21 valve tags for coordinated format between each Division.

C. Valve tags shall be coordinated with existing facility valve tags and Contractor shall obtain a copy of existing facility valve chart and provide updated valve chart to the Owner’s Representative.

2.9 DUCTWORK AND PIPING SYSTEM IDENTIFICATION

A. Means of Identification: All piping and duct systems installed and/or modified as part of this project shall be identified by each of the means described below. The Contractor shall provide shop drawing submittal data for proposed labeling system materials and manufacturer's recommended installation procedures.

B. Piping Systems shall be identified by means of an identifying legend on color coded background appropriately worded to indicate the "service" name of the pipe as shown on the drawings. Color coded banding shall also be provided. Additionally, an arrow shall be included to indicate the direction of flow through the pipe.

C. Ductwork shall be identified at or near the fan, with stenciled signs on insulated ductwork or by engraved laminated plastic signs secured by rustproof screws on un-insulated ductwork. Sign shall identify air conditioning system or fan unit and area served. All exposed ductwork located in equipment room areas shall be labeled at 20 foot intervals. In addition, ductwork concealed above rigid ceilings and inside walls and chases shall be labeled at all access doors.

D. Locations of Piping System Identification: The identifying legends and directional arrows described in the paragraphs preceding shall be located at the following points on each piping system:

Adjacent to each valve in piping system.
At every point of entry and exit where piping passes through a wall.
On each pipe riser and junction.
At a maximum interval of 20 feet on pipe lines exposed and concealed above accessible ceilings.
Adjacent to all special fittings (regulating valves, etc.) in piping systems.
At every access door.

E. Piping identification shall meet the standards of the Federal Occupational Safety Health Act (OSHA) which refers to the ANSI Standard A13.1. The following standardized color code scheme shall be used:

Yellow - Hazardous Materials
Green - Liquid Materials of Inherently Low Hazard
Blue - Gaseous Materials of Inherently Low Hazard
Red - Fire Protection Materials

F. The size of letter and length of color field shall conform to the ANSI standard and shall be as follows:

Outside Diameter of Pipe or Covering	Length of Color Field	Size of Letters
------ to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

G. All pipe labels exposed within mechanical equipment spaces shall be semi-rigid plastic identification markers. Each label shall have appropriately color-coded background with printed legend. Directional flow arrows shall be included on label. Labels shall "snap-on" around pipe without the requirement for adhesive or bonding of piping sizes 3/4" through 5". Labels for piping 6" and larger shall be furnished with spring attachment at each end of label. Labels shall be "SETMARK" Type SNA, 3/4" through 5" size and Type STR, 6" and larger, as manufactured by Seton Name Plate Corporation, Brady, or equivalent.

H. All pipe labels except pipe labels located exposed within the mechanical equipment spaces shall be vinyl material with permanent adhesive for application to clear dry pipe and/or insulation jacketing. Each label shall have appropriate color-coded background with printed legend. Direction arrows shall be placed next to label to indicate flow direction. Color and size of arrows shall correspond to that of label. Pressure sensitive pipe tape matching the background color of the label shall be placed over each end of the label and completely around the pipe.

I. Attach pipe markers to lower quarter of the pipe on horizontal runs and on the centerline of vertical piping where view is not obstructed. Flow indicator arrow shall point away from pipe marker.

J. Provide the following labels, with ANSI/OSHA color for all piping systems as shown on the drawings and as listed below:

Service/Legend	Letter Color	Background Color
Natural Gas	Black	Yellow
Heating Water Supply	Black	Yellow
Heating Water Return	Black	Yellow

2.10 IDENTIFICATION OF CONTROL SYSTEM DEVICES

A. All automatic controls, control panels, zone valves, pressure electric, electric pressure switches, relays and starters shall be clearly tagged and identified. Wording shall be identical to that on the control diagram in the contract drawings.

2.11 UNDERGROUND PIPING SYSTEM IDENTIFICATION

A. Bury a continuous, preprinted, bright colored, plastic ribbon cable marker with each underground pipe regardless of whether encased. Locate directly over buried pipe, 6" to 8" below finished grade. Marker tape used in conjunction with buried plastic piping systems shall be special detector type. Marker tape used in conjunction with buried plastic piping systems shall be special detection type.

2.12 EQUIPMENT TAGS

A. Furnish and install equipment identification tags for all items of HVAC equipment furnished and installed under Division 23, including each air supply unit or fan, each exhaust fan, each pump, each converter or heat exchanger, each chiller, each boiler, each special filter system, each air washer, and other equipment as listed on the mechanical equipment schedule. Equipment tags shall be a minimum of 3/32" thick laminated phenolic plastic.

2.13 ACCESS DOORS

A. Provide all access doors required for access to valves, dampers, controls, or other items for which access is required for either operation or servicing. All costs incurred through failure to perform this function as the proper sequence of this work shall be borne by the Contractor. The type of access door shall be as required by the room finish schedule. Acoustical tile access doors shall be equal to Krueger Style B, Style A for acoustical plaster, Style C-CE for sidewall drywall or plaster construction.

B. Access doors shall be not less than 24" x 24" in size except that larger panels shall be furnished where required, and panels in tile or other similar patterned ceilings shall have dimensions corresponding to the tile or pattern module.

C. Where access doors are installed in walls required to have a specific fire rating, the access door installed shall be a fire rated access door with UL label, as manufactured by Milcor or equivalent.

Access door in 1-hour construction shall be Class C and access doors in 2-hour construction shall be Class B.

PART 3 - EXECUTION

3.1 COOPERATION WITH OTHER TRADES

A. The Contractor shall refer to other parts of these specifications covering the work of other trades which must be carried on in conjunction with the mechanical work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. The Contractor shall be responsible for the size and accuracy of all openings.

3.2 SYSTEMS COMMISSIONING

A. A commissioning Agent will participate in the construction phase of the project. The Contractor shall fully cooperate with this effort as defined in Section 23 0800 and Division 1.

3.3 DRAWINGS

A. The HVAC drawings show the general arrangement of HVAC piping, ductwork, equipment, etc., and shall be followed as closely as actual building construction and work of other trades will permit. Whenever discrepancies occur between plans and specifications, the most stringent shall govern. All Contract Documents, including but not limited to Division 21 Fire Suppression, Division 22 Plumbing and Division 26 Electrical shall be considered as part of the work insofar as this information furnishes the Contractor with details relating to design and construction of the building. Architectural and structural drawings shall take precedence over the HVAC, plumbing and fire suppression drawings. Because of the small scale of the HVAC, plumbing and fire suppression drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. The Contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings, valves, and accessories as may be required to meet such conditions. Should conditions necessitate a rearrangement of piping, such departures and the reasons therefore shall be submitted by the Contractor for review in the form of detailed drawings showing the proposed changes. No such changes shall be made without the prior written approval. All changes shall be marked on the set of record drawings by the Contractor.

B. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, the question shall be submitted in writing.

C. Installation of all HVAC equipment, piping, ductwork, and electrical systems shall be arranged to provide all clearances required for equipment operation, service, and maintenance, including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC). Piping and ductwork systems shall not be routed through or above electrical equipment room or electrical equipment space designed within mechanical equipment rooms.

D. The Contractor's attention is directed to the unique architectural design features and consideration associated with this facility which will require significantly greater levels of coordination and

cooperation for the work furnished and installed under Division 23 with the associated architectural, structural, and electrical work than is normally necessary for a more typical facility.

E. The installation of all concealed HVAC systems shall be carefully arranged to fit within the available space without interference with adjacent structural and electrical systems. The Contractor shall make all necessary provisions for penetrations of piping and ductwork, including sleeves and blackouts in structural systems. The exact location of all exposed HVAC systems, including grilles, registers, and diffusers; access doors; piping and ductwork exposed within finished areas; and other equipment and devices as applicable, shall be coordinated with the Architect, who shall have final authority for the acceptance of the work as it specifically relates to the architectural aesthetic design requirements for the facility.

3.4 FIELD MEASUREMENTS

A. The Contractor shall verify the dimensions and conditions governing his work at the building. No extra compensation shall be claimed or allowed on account of differences between actual dimensions, including dimensions of equipment, fixtures and materials furnished, and those indicated on the drawings. Contractor shall examine adjoining work, on which his work is dependent for perfect efficiency, and shall report any work which must be corrected. Coordination of all HVAC work within the building will be the direct responsibility of the Contractor. Review of submittal data in accordance with paragraph "Submittals" shall in no manner relieve the Contractor of responsibility for the proper installation of the HVAC work within the available space. Installation of equipment and systems within the building space shall be carefully coordinated by the Contractor with all building trades. Each contractor shall so harmonize his work with that of the several other trades that it may be installed in the most direct and workmanlike manner without hindering or handicapping the other trades. Piping interferences shall be handled by giving precedence to pipe lines which require a stated grade for proper operation. Sewer lines shall take precedence over water lines in determination of elevations. In all cases, lines requiring a stated grade for their proper operation shall have precedence over electrical conduit and ductwork. Installation of HVAC, plumbing and fire suppression systems within the ceiling cavity shall be in the following order of priority: plumbing waste lines; roof drains; supply, return, outside air, makeup, and exhaust ductwork; fire sprinkler mains; fire sprinkler branch piping and sprinkler runouts; chilled water and heating water piping; domestic hot and cold water; control piping, wiring and conduit; and miscellaneous special piping systems.

3.5 QUIPMENT SUPPORT

A. Contractor shall provide support for equipment to the building structure. Contractor shall furnish all necessary structures, inserts, sleeves, and hanging devices for installation of mechanical and plumbing equipment, ductwork and piping, etc. Contractor shall completely coordinate installation of such devices with all trades and Sub-Contractors. Contractor must further verify that the devices and supports are adequate as intended and do not overload the building's structural components in any way.

3.6 PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be responsible for the protection of all work, materials and equipment furnished and installed under this section of the specifications, whether incorporated in the building or not.

B. Air handling equipment, fans, air terminal units and other items of HVAC equipment and materials, including ductwork and piping, valves and fittings, etc., shall be protected from damage and contamination. Equipment and materials shall not be stored outside and exposed to weather and ambient conditions without appropriate protection measures and without the approval of the Architect. Ductwork sections, air terminal units, fan coil units, heat pump units, etc., shall be delivered to the jobsite and maintained while on the jobsite with all openings, controls and control panels covered with sheetmetal caps, with heavy duty polyethylene wrap or other proper means. Equipment and materials where stored within the building shall be protected at all times from construction damage and contamination from dust, dirt, debris, and especially during fireproofing, painting and gypboard sanding and finishing. Unprotected equipment, piping, and ductwork will require special field cleaning by the Contractor prior to acceptance by the Architect.

C. The Contractor shall be responsible for all damage done to property, equipment and materials. Storage of materials within the building shall be approved by the Architect prior to such storage.

D. At the completion of the HVAC work, equipment and materials shall be cleaned and polished thoroughly and delivered in a condition satisfactory to the Architect.

3.7 TRENCHING AND BACKFILLING

A. All excavation, trenching and backfilling required for the HVAC installation shall be provided by this Contractor.

3.8 MANUFACTURER'S INSTRUCTIONS

A. All equipment shall be installed in strict accordance with recommendations of the manufacturer. If such recommendations conflict with plans and specifications, the Contractor shall report such conflicts to the Architect, who shall make such compromises as he deems necessary and desirable.

3.9 CONCRETE BASES AND HOUSEKEEPING PADS

A. Concrete bases and housekeeping pads shall be installed under all pieces of mechanical equipment unless specifically deleted by the specifications or drawings.

B. Contractor shall be responsible for the accurate dimensions of all pads and bases and shall furnish and install all vibration isolators, anchor bolts, etc.

C. Contractor shall provide concrete housekeeping pad foundations for all floor mounted equipment installed under this section unless otherwise shown on the drawings. All concrete bases and housekeeping pads shall conform to the requirements specified under Division 3, Concrete, portions of these specifications. Pad foundations shall be 4" high minimum, unless otherwise indicated on the drawings. Chamfer edges shall be 1". Faces shall be free of voids and rubbed smooth with carborundum block after stripping forms. Tops shall be level. Provide dowel rods in floor for lateral stability and anchorage.

D. Equipment anchor bolts shall be set in a galvanized pipe or sheet metal sleeves 1" larger than bolt diameter. Anchor bolts shall be high strength steel J shape. Anchor bolt design shall be arranged and paid for by the Contractor.

E. Machinery bases, bed plates, sole plates, or vibration isolation units shall be carefully aligned, shimmed, leveled, then grouted in place with commercial non-shrink grout. When a flexible coupling is employed as a part of the drive train, the coupling shall be aligned before the machinery base is grouted.

3.10 EQUIPMENT FURNISHED UNDER OTHER SECTIONS OF THESE SPECIFICATIONS

A. Certain items of HVAC equipment as listed on the drawings and/or specifications will be furnished under other Sections of this specification. All mechanical rough-in and connection for this equipment shall be provided under Division 23, including process cooling water, exhaust, etc.

3.11 ALIGNMENT OF FLEXIBLE COUPLINGS

A. Flexible couplings between motors and driven equipment shall be aligned by the qualified service technician after the equipment is installed and ready for operation. Proper aligning shall be provided within manufacturer's maximum alignment tolerance at equipment operating conditions and temperature. Alignment shall follow unit manufacturer's written procedures using approved dial indication methods for parallel and angular alignment. The Contractor shall provide written certification that each device has been so aligned.

3.12 LUBRICATION

A. The Contractor shall provide all oil for the operation of all equipment until acceptance. The Contractor shall be held responsible for all damage to bearings while the equipment is being operated by him up to the date of acceptance of the equipment. The Contractor shall protect all bearings and shafts during installation and shall thoroughly grease the steel shafts to prevent corrosion. Bearings for items of HVAC equipment shall be marked at each bearing location as to whether the bearing is a sealed type or relubricable type unit.

3.13 PRESSURE RELIEF DEVICES

A. Refrigerant pressure relief devices and fusible plugs shall be installed with piping to a safe location in accordance with ANSI/ASHRAE Standard 15-1994. Discharge shall be to atmosphere at a location not less than 15 feet above the adjoining ground level and not less than 20 feet from any window, ventilation opening, or exit from any building. Discharge line sizing shall conform to ANSI/ASHRAE Standard 15-1994.

B. Each discharge pipe shall be equipped with a drip leg capable of holding 1 gallon of liquid. The drip leg shall include a manual drain valve.

3.14 TESTS

A. Tests shall be conducted in the presence of the designated and authorized Owner's Representative. The Contractor shall notify the Architect a minimum of one week in advance of scheduled tests. Requirements for testing are specified under the sections covering the various systems. The Contractor shall furnish all necessary equipment, materials, and labor to perform the required tests.

3.15 INSTALLATION CHECK

A. An experienced, competent, and authorized representative of the equipment listed below shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is approved and accepted.

B. Each equipment supplier's representative shall furnish a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it has operated satisfactorily.

C. Equipment requiring installation check includes the following**:**

Boilers
Pumps
Variable Frequency Drives
Water Treatment Systems
Air Handling Units
In-line Fans
Centrifugal Fans
In-line Centrifugal Fans
Utility Sets
DX Split Systems
Vibration Isolators
Terminal Units

3.16 OPERATION AND MAINTENANCE INSTRUCTIONS

A. The Contractor shall furnish complete operating and maintenance instructions covering all units of HVAC equipment herein specified together with parts lists. Equipment spare parts shall include all components requiring service, including motors, v-belts, bearings, shafts, etc. Provide tabular listing of all air filter sizes for all HVAC units, filter grilles, etc. Furnish two (2) copies of all the literature; each shall be suitably bound in loose leaf book form**.** A "Lubrication Chart" framed under plexiglass shall be provided listing all types of oil to be used for each piece of equipment and the recommended frequency of lubrication. This chart shall be hung on the wall of the equipment room.

B. Complete temperature control diagrams including control descriptions, system sequence of operation and operating instructions shall also be provided, in duplicate suitably bound in loose leaf book form. In addition, one copy of the schematic pneumatic and electric control diagrams shall be framed under plexiglass and mounted on the equipment room wall in the vicinity of the installed equipment.

C. See Division 1 for additional requirements concerning manuals, manual distribution, and maintenance materials.

D. Operating and maintenance manuals as required herein shall be submitted for review and distribution to the Owner not less than two (2) weeks prior to the date scheduled for the Contractor to provide Operating and Maintenance Instructions to the Owner as specified herein.

E. Upon completion of all work and all tests, Contractor shall furnish the necessary skilled labor and helpers for operating the HVAC systems and equipment for a period of five (5) days of eight (8) hours each. During this period, the Contractor shall instruct the Owner or his representative fully in the operations, adjustment and maintenance of all equipment furnished. Contractor shall provide at least two weeks notice in advance of this period, with a written schedule of each training session, the subject of the session, the Contractors' representatives who plan to attend the session, and the time for each session.

F. The Contractor shall video tape the instruction and training sessions using a VHS camcorder, and at the completion and acceptance (by Owner and Architect) of the training sessions, the Contractor shall submit (2) copies of the video tape.

G. Operational test shall be conducted by the Contractor with the assistance of the representatives from the Temperature Control Sub-Contractor, and Testing and Balancing Sub-Contractor. Test shall be conducted in the presence of the designated and authorized Owner's Representative.

3.17 CERTIFICATIONS

A. Before receiving final payment, the Contractor shall certify in writing that all equipment furnished and all work done is in compliance with all applicable codes mentioned in these specifications. Submit certifications and acceptance certificates, including proof of delivery of O&M manuals, spare parts required, and equipment warranties which shall be bound with O&M manuals.

3.18 CONSTRUCTION PHASING AND SCHEDULE

A. All work furnished and installed under Division 23 of this Specification shall be provided in accordance with the project schedule and phase requirements as described on the Architectural Drawings and Specifications.

3.19 HVAC SYSTEM SHUTDOWN AND REACTIVATION

A. The Contractor shall shutdown existing facility HVAC equipment and piping systems as required for installation of the project HVAC construction work. As a part of the required work, the Contractor shall drain down the existing systems and after completion of new work and pressure testing of systems, the Contractor shall refill the systems and re-establish proper system circulation, remove all air from piping system and equipment, fill and charge expansion tanks, and place system in full and proper operation.

B. The Contractor shall furnish and install all water treatment chemicals necessary for the refilling and reactivation of the systems as required to maintain a level of chemical concentration as

recommended by the water treatment agency. Water treatment chemicals shall be of the specific type recommended by the water treatment agency.

C. The Contractor shall coordinate installation of chemical water treatment with the water treatment agency and shall provide written notification of system reactivation and water treatment installation. The water treatment agency shall provide an independent test of the system water treatment condition and submit written report.

3.20 OPERATION PRIOR TO ACCEPTANCE

A. Operation of equipment and systems installed by the Division 23 Contractor for the benefit of the Owner prior to substantial completion will be allowed providing a written agreement between the Owner and the Contractor has established warranty and other responsibilities to the satisfaction of both parties.

B. Operation of equipment and systems installed by the Division 23 Contractor, for the benefit of the Contractor, except for the purposes of testing and balancing will not be permitted without a written agreement between the Owner and the Contractor establishing warranty and other responsibilities.

3.21 SITE VISITS AND OBSERVATION OF CONSTRUCTION

A. The design professional shall make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the Contractor's work, in order to determine in general if such work is proceeding in accordance with the Contract Documents. This observation, however, shall in no way release the Contractor from his complete responsibility to supervise, direct, and control all construction work and activities. The design team has no authority over, or a responsibility to means, methods, techniques, sequences, or procedures of construction provided by the Contractor or for safety precautions and programs, or for failure by the Contractor to comply with all law, regulations, and codes.

B. Prior to the "Final" observation visit, the attached "Final Observation Checklist" shall be completed by the Contractor. Any non-applicable items shall be marked "N/A." The completed form shall be submitted, indicating that all necessary items are complete and requesting a final observation within 10 days. The Contractor shall be notified of any uncompleted items within seven (7) days. A resubmittal of the form and a new final observation request by the Contractor is required if the form is returned and noted as incomplete.

END OF SECTION 23 0500

Project:_____ **Date Submitted**_____
General Contractor:_____ **Date of Final HVAC System**_____
Mechanical Contractor:_____ **Observation Requested**_____

CONTRACTOR'S DIVISION 23 HVAC CHECK LIST
(ALL APPLICABLE ITEMS MUST BE COMPLETED PRIOR TO FINAL OBSERVATION)

In advance of requesting a final mechanical observation for installed mechanical systems, please check all items that have been completed. For all items not applicable to this project mark N/A.

HVAC/PIPING

_____1. All HVAC pipe systems are insulated.

_____2. All pipe systems are identified with specified labels and directional arrows.

_____3. Valve tags are installed.

_____4. Special piping systems have been cleaned and pressure tested.

_____ Fuel Handling
_____ Natural Gas
_____ Other

_____5. HVAC/piping connections have been completed to Owner furnished equipment and equipment furnished by other Contractors/Sub-Contractors.

_____6. Drains and relief lines from HVAC equipment have been installed and secured in a proper manner.

_____7. All HVAC equipment required by the Specifications has been identified and/or numbered.

_____8. Refrigerant piping/system has been charged and tested.

_____9. Strainers/suction diffusers have been cleaned.

_____10. Backflow preventers have been tested.

_____11. Air has been vented from all coils and systems.

_____12. Water treatment systems have been charged and tested.

_____ Chilled Water _____ Condenser Water
_____ Hot Water _____ Steam/Condensate
_____Other

_____13. Ethylene glycol system has been charged with correct mixture and tested.

_____14. Water systems have been cleaned (X) and pressure tested (P).

_____ Chilled Water _____ Condenser Water

_____ Hot Water	_____ Non-potable Water
_____ Steam	_____ Condensate
_____ Heat Recovery Piping	_____ Other (list)

_____15. PRV's have been adjusted (water, steam, gasses).

HVAC - EQUIPMENT AND DUCTWORK

_____1. All ductwork has been sealed and insulated.

_____2. Return air paths and transfer openings have been verified.

_____3. Air handlers have been cleaned inside and out and construction filters removed and replaced with final filters.

_____4. All air handling equipment has been started and operated for the specified time.

_____5. All equipment isolators have been adjusted for specified deflection.

_____6. All VAV boxes, fan coils, or fan powered boxes are completed and operational.

_____7. All pump shafts and couplings have been aligned.

_____8. Ductwork, coils, housing, diffusers, registers and grilles have been cleaned.

_____9. Boilers have been fired and certified by the supplier.

_____10. Cooling towers have been started and inspected by the supplier.

_____11. Chillers have been charged, started and certified for operation by the supplier.

_____12. Fire dampers and combination fire/smoke dampers are accessible and fully operational.

_____13. All HVAC equipment has been lubricated.

_____14. HVAC equipment has been labeled in accordance with the specifications.

_____15. Duct pressure testing is complete and accepted.

_____16. "HAZARDOUS AREA" signs installed where applicable.

_____17. Belt guards installed where applicable.

_____18. Variable frequency drives have been tested by the manufacturer's representative and certified to be in compliance with all of the specified requirements.

_____19. Testing and balancing has been completed, and deficiencies noted have been corrected.

_____20. Special systems have been started and tested, such as: Humidification, laboratory hoods, kitchen hoods, and Owner furnished items.

TEMPERATURE CONTROLS

_____1. Temperature control panels and devices have been labeled in accordance with the specifications.

_____2. All control dampers close completely and edge and blade seals form tight seal.

_____3. All control valves have been piped as required by the drawings.

_____4. Pneumatic controls systems are completed and all control points are operating and recording properly.

_____5. All temperature control tubing and wiring is installed and secured in accordance with the specifications and the electrical code.

_____6. Smoke removal fans and/or smoke detectors have been tested for operation and shut-down.

_____7. Freezestats have been tested ensuring fan shut-down and full damper closure.

_____8. Operator training for temperature controls has taken place.

_____9. Refrigerant sensors and equipment room shut-down have been tested.

_____10. All trend logs required by Section 23 0900-3.3-7 indicating satisfactory system response and have been submitted to the Engineer.

GENERAL ITEMS

The following specified items have been submitted:

_____1. Record drawings (to be submitted prior to final payment to the Contractor).

_____2. Operation and maintenance manuals.

_____3. Manufacturer's representative installation check and certification submitted (see list of equipment, Section 23 0500).

_____4. Testing and balancing reports.

_____5. Test kits furnished to Owner.

_____ Flow Measuring Devices
_____ Flow Balance Valves
_____ Flow Control Devices

_____6. Temperature control schematics and sequence of operation.

_____7. Wall mounted lubrication, valve, and temperature control charts have been installed.

END CHECKLIST

DIVISION 23 SUBSTITUTION REQUEST FORM (SRF)

TO: BRIDGERS & PAXTON CONSULTING ENGINEERS, INC.
PROJECT: _____

We hereby submit for your consideration the following product instead of the specified item for the above project:

Section: _____Page: _____Paragraph/Line: _____Specified Item: _____

Proposed Substitution: _____

Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitutions?
   YES ☐ NO ☐
   If YES, explain:_____

2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions? YES ☐ NO ☐

3. List differences between proposed substitutions and specified item.

Specified Item	Proposed Substitution
_____	_____
_____	_____
_____	_____

4. Does substitution affect Drawing dimensions? YES ☐ NO ☐

5. What affect does substitution have on other trades?_____

6. Does the manufacturer's warranty for proposed substitution differ from that specified?
   YES ☐ NO ☐ If YES, explain:_____
   _____

7. Will substitution affect progress schedule? YES ☐ NO ☐
   If YES, explain:_____
   _____

8. Will maintenance and service parts be locally available for substitution? YES ☐ NO ☐
   If YES, explain:_____
   _____

9. Does proposed product contain asbestos in any form? YES ☐ NO ☐

SUBMITTED BY: Firm: _____Date: _____

Address: _____

Signature: _____Telephone: _____

FOR ENGINEER'S USE ONLY:

Accepted_____ Not Accepted _____ Received Too Late _____

By: _____ Date:_____

Remarks:_____

_____

LICENSE, INDEMNITY AND WARRANTY AGREEMENT

BETWEEN: Bridgers & Paxton Consulting Engineers
4600-C Montgomery Blvd. NE
Albuquerque, NM 87109

and the Contractor: **[NAME]**
[Address]
[Address]

For use of BIM – Building Information Modeling produced by Bridgers & Paxton Consulting Engineers, Inc. (B&P) in conjunction with the referenced project:

PROJECT: Farmington Municipal Schools, Preschool Academy East Replacement
B&P Job #8819

THE CONTRACTOR ACKNOWLEDGES THE FOLLOWING:

1. The model remains the property and control of B&P unless otherwise stipulated in separate contractual agreements with the Architect and/or Owner. Providing access to the model does not transfer copyright or ownership, and is a limited license to use in accordance with these and other conditions set by B&P. The Contract Documents do not require the Contractor to use the model to prepare drawings in electronic format for use during construction, or the use in any way of BIM or CAD systems. The Contractor is not permitted to make alterations to the design model and/or the information contained therein without prior approval from B&P.

2. The model and the information contained is provided as is, the Revit Version 2012 (or earlier version as required by the project) format used by B&P. The model is provided without warranty or guaranty of compatibility with the Contractor's software or hardware systems. Further, the Contractor acknowledges data stored within the model can be altered, wither intentionally or unintentionally, by transcription, machine error, environmental factors, duration, and method of storage, and/or computer operators.

3. The model, and the information contained therein is provided for the Contractor's convenience only, is not a Contract Document and does not relieve the Contractor from the requirements of the Contract Documents. The information provided in the model may not reflect the Contract Documents in all areas and the Contractor will be required to verify where changes have occurred. Also, field verification of existing and as-built conditions are required as part of a submittal process as applicable per project requirements. The official Contract Document set will be used as the precedent and authoritative document, and, in comparison with electronic files, shall supersede any discrepancies, omissions, or errors shown on the electronic files.

4. The design model may contain information provided by others. B&P cannot guarantee or warrant the accuracy and completeness of information provided by others.

5. The information provided in the model is only diagrammatic reflecting design intent. Contract Documents require that the work and coordinated shop drawings reflect actual field verified conditions with actual equipment/duct sizes, utility locations, and related site/project conditions.

6. The Contractor accepts responsibility for ensuring all persons, including sub-contractors, using the model complies with the requirements and limitations in using the information provided to them. Further, the use of the model is limited solely to this project. Use of the model or contents within on other projects or on other applications by the Contractor is expressly prohibited.

7. This Hold Harmless Agreement shall be attached to and transmitted with the design model at all times so that all those that the Contractor allows to have access are bound by the terms of this Agreement.

ACKNOWLEDGEMENT

1 By accepting the design model and the above stipulations, the Contractor and its agents, employees, Subcontractors of any tier, material suppliers or any others that Contractor allows to access the model agrees to defend, indemnify and hold harmless the Owner and Bridgers & Paxton Consulting Engineers, Inc., their agents, employees against all claims, liabilities, damages, losses, expenses and costs (including expert and attorney's fees) (Claims) arising from, relating to or resulting from their use of the design model (BIM).

ACCEPTED:
CONTRACTOR REPRESENTATIVE

Authorized Signature: _____

Title: _____

Date: _____

SECTION 23 0501 - DEMOLITION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

1.2 RELATED SECTIONS

A. See Section 23 0500, for Common Work Requirements for HVAC.

B. See Division 1, for Cutting and Patching.

1.3 SCOPE OF WORK

A. The terms "demolish" and "remove" shall mean disconnect, cart away, and dispose of off site. Components to be demolished or removed include all materials, equipment, building construction, and other components as indicated. Components to be demolished shall become the property of the contractor, and contractor may dispose of them by either landfilling or by selling salvageable parts and recyclable materials to legitimate third parties.

B. Except as specifically noted, asbestos abatement will be by others, and is not included in this contract. Advise Owner sufficiently in advance of demolition work so that Owner may arrange to have asbestos removed without delaying demolition or construction work.

C. The Owner retains the first right of refusal on all components to be removed. When requested, remove components carefully and deposit components in locations as directed by the Owner.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 GENERAL

A. Within four weeks after notice to proceed, and a minimum of two weeks prior to any demolition activities, submit a project schedule indicating all demolition work. Schedule all work to minimize interruptions in utility services to the facility. Interruptions generally will be allowed only outside normal operating hours. Sequence all work in accordance with the drawings and the Project Manual.

B. Take care not to damage equipment, materials, components, and building construction which is

to remain in service. Provide blind flanges, caps, etc, so as to prevent accidental discharge of water, etc.

C. Do not interfere with the Owner's access to buildings and equipment. If any activities cause interference which is objectionable to the Owner, contractor shall modify his means and methods, or reschedule those activities outside occupied hours at no additional cost to the Owner.

D. Where existing systems must remain in service during the construction project, make whatever provisions are necessary to accomplish this. This includes providing blind flanges and caps, temporary insulation, duct caps, etc, to allow for proper system operation.

3.2 EQUIPMENT

A. General: Disconnect and remove piping, ductwork, controls, power, and equipment supports. Wherever possible, remove equipment as a whole. Do not cut up equipment in place unless approved in advance by the Owner.

B. Chillers: Drain water in evaporator and condenser to sanitary sewer system. Remove refrigerant and either recycle or dispose of as a hazardous material. Remove oil and dispose of as a hazardous material. Comply with all applicable regulations, including the Clean Air Act and RCRA. Submit documentation showing final owner and location of refrigerant and oil.

C. Boilers: Water in boiler, condensate system, and boiler feed system may be drained to the sanitary sewer system. Remove boilers, steam piping, blowdown systems, condensate piping, condensate pumps, boiler feed pumps, safety relief piping, breeching, stacks, and all associated piping and accessories. Repair concrete floor. Remove chemicals and chemical feed equipment. Chemicals shall be either reused by chemical supplier, or properly disposed of in accordance with all applicable regulations including RCRA. Submit documentation showing final owner, location, and means of disposal for chemicals.

D. Cooling Tower: Drain water to sanitary sewer system. Disassemble tower as required, cart away, and dispose of all components. Wood members shall be disposed of as hazardous materials. Comply with all applicable regulations, including RCRA. Submit paperwork documenting the final owner, location, and means of disposal for all wood members. Demolish and cart away the concrete basin for the cooling towers and condenser water pumps. Backfill with approved fill material to grades which will ensure proper drainage. Compact to 95% Standard Proctor Density. Restore surfaces as indicated.

3.3 PIPING

A. Disconnect piping as indicated, and remove all piping not required in the final, upgraded condition of the systems. This includes removal back to the headers and mains which must remain in service. The existing valving may not hold tight. Arrange in advance for shutdowns as required. Provide caps, blind flanges, etc. as indicated on drawings, as required to facilitate construction activities, and as required to facilitate owner's use of the system.

B. Remove all components in piping system, including valves, fittings, flanges, strainers, anchors, guides, hangers, supports, supplementary steel, attachments to structure, instrumentation,

insulation, etc.

C. Patch all openings in walls, floors, roofs, partitions, gratings, etc, which remain after piping is removed.

D. Provide vents and drains in the piping which will remain in service, where necessary to facilitate refilling, venting, and future system operation.

3.4 DUCTWORK

A. Disconnect ductwork as indicated, and remove all ductwork not required in the final, upgraded condition of the systems. This includes removal back to the mains which will remain in service. Arrange in advance for shutdowns as required. Provide caps as indicated on drawings, as required to facilitate construction activities, and as required to facilitate the Owner's temporary and final use of the systems.

B. Remove all components in ductwork system including fittings, dampers, grilles, registers, diffusers, louvers, hangers, supports, supplementary steel, attachments to structure, instrumentation, insulation, acoustic lining, etc.

C. Patch all openings in walls, floors, roofs, partitions, gratings, etc, which remain after ductwork is removed.

3.5 CONTROLS

A. Remove all controls associated with equipment, piping and ductwork which are to be removed. Controls shall include instrumentation, control panels, wiring, conduits, tubing, supports, and attachments to structure. Where wiring is run in conduit in concealed locations, remove the wiring, cap both ends of conduit, and label conduit as "ABANDONED" at both ends.

3.6 ELECTRIC POWER

A. Remove all electric power associated with equipment, controls and accessories which are to be removed. Electric power shall include starters, disconnects, wiring and conduit from MCC's and distribution panels to local starters and disconnects, wiring and conduit from local starters and disconnects to equipment, supports, attachments to structure, and concrete housekeeping pads. Label all associated breakers as "SPARE." Where MCC's serve equipment to be removed and no new equipment is to be served from the same starter, leave the starter in place and label it as "Spare Size X Starter."

B. Where wiring runs in conduit within concealed locations, remove the conductors, cap both ends of conduit, and label conduit as "ABANDONED" at both ends. Where wiring runs below grade, remove conductors, cap conduit at both ends, and abandon in place. Where wiring runs below concrete floor slabs, chip out concrete around conduit, remove conduit to bottom of slab level, and patch floor to match adjacent surfaces.

3.7 EQUIPMENT SUPPORTS

A. Housekeeping Pads: Remove housekeeping pads for equipment to be removed. Remove all tripping hazards and resurface floor to match surrounding floor.

B. Equipment Foundations: Remove foundations, remove all tripping hazards, backfill as required, compact to 95% Standard Proctor Density, and pour floor slab to match existing.

C. Support Steel: Remove all support steel including attachments to building or to grade.

3.8 MEANS OF ACCESS

A. Remove all service platforms, catwalks, ladders, etc. which are required solely for the equipment, valves, and instrumentation which are being removed as part of this work.

3.9 TEMPORARY REMOVALS

A. Carefully remove and store the following components for reinstallation under this contract. Report any operating deficiencies prior to removal. After reinstallation, place components back in service and demonstrate proper operation.

END OF SECTION 23 0501

SECTION 23 0504 - PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplementary Conditions and General Requirements.

B. Lead Ban: All piping, solder and flux used in the installation of piping systems furnished and installed under Division 23, shall be lead free. The term lead free is defined as pipe which does not contain more than 8.0% lead and solder and flux which does not contain more than 0.2% lead.

1.2 RELATED SECTIONS

A. See Section 23 0500, for Common Work Requirements for HVAC.

1.3 SUBMITTAL DATA

A. Contractor shall furnish complete submittal data for all piping materials, including manufacturer's specifications, certifications, class, type and schedule. Submittal data shall additionally be furnished for pipe hangers and supports, pipe sleeves including sealing and fire safing materials and installation.

PART 2 - PRODUCTS

2.1 PIPE AND PIPE FITTINGS

A. Piping system materials shall be furnished as specified under the Sections describing the various piping systems. Pipe fittings shall be compatible with the piping systems in which they are installed. All HVAC gravity condensate drainage piping system shall be wrought copper conforming to ANSI B16.22.

B. Pipe fittings for steel piping systems shall be weld, screwed. Butt weld fittings shall be manufactured by Weld-Bend, Laddish, or equivalent, standard or extra strong as specified in the applicable Sections of this Specification, conforming to ANSI Standard B16.9. All 90^0 weld elbows shall be long radius unless otherwise specified. Wherever tee connections are required in the piping system, manufacturer's straight or reducing tees shall be utilized. The use of fittings formed from welded pipe or pipe sections will not be permitted. Forged steel "Weld-O-Lets," "Branch-O-lets," and "Thred-O-Lets," as manufactured by Bonney Forge or equivalent, may be utilized for welded branch and tap connections up to one-half the size of the main. Forged steel half-couplings conforming to ANSI B16.11 may be used for drain, vent and gauge connections. Flanges shall be forged steel weld neck or slip-on, raised face, Class 150 or 300 as specified in the applicable Sections of this Specification with full face or ring type non-asbestos gasket material suitable for the application.

C. Socket weld fittings shall be Schedule 40, 2000 pound or Schedule 80, 3000 pound construction, as specified in the applicable Sections of this Specification, conforming to ANSI B16.11, as manufactured by Grinnell or equivalent.

D. Screwed fittings shall be Class 150 standard or Class 300 extra heavy, black or galvanized, malleable iron or cast iron, as specified in the applicable Sections of this Specification, as manufactured by Grinnell or equivalent. Screwed malleable iron fittings shall conform to ANSI B16.3 and cast iron screwed fittings shall conform to ANSI B16.4. Bushing reduction of a single pipe size or use of close nipples will be permitted.

E. Pipe fittings for copper piping system shall be wrought copper conforming to ANSI B16.22. Cast brass fittings conforming to ANSI B16.23, may be utilized for sanitary drainage, waste and vent systems, HVAC gravity condensate drainage system, and other non-pressure applications.

F. Bronze flanges, Class 125 and Class 150, shall conform to ANSI B16.24.

G. Cast iron fittings for cast iron sanitary soil, waste, and venting piping systems shall be as specified in Division 22.

H. Ductile iron fittings for ductile iron water service piping systems shall be as specified in Division 22.

2.2 FLOOR, WALL AND CEILING PLATES

A. Where uncovered, exposed pipes pass through finished floors, finished walls, or finished ceilings, they shall be fitted with chromium plated spun brass escutcheon plates. Plates shall be large enough to completely close the hole around the pipe, and shall be not less than 1-1/2" or more than 2-1/2" larger than the diameter of the pipes. All plates shall be securely held in place.

2.3 UNIONS

A. Piping 2-1/2" and larger shall be provided with bolted flange union connections. Weld flanges and bolting shall conform to ANSI B16.5. Bronze flanges shall conform to ANSI B16.24. Flange class shall be as specified in the applicable Sections of the Specifications.

B. Malleable iron grooved joint unions with brass to iron seats, Class 125, 250, or 300, as required by the application and compatibility requirements with the piping system fitting classification, conforming to MSS SP-77 and ANSI B16.39, shall be provided in piping systems 2" and smaller. Copper unions conforming to ANSI B16.22 shall be provided in copper piping systems. Union connections shall be installed at all coils, control valves, equipment connections, and at other locations shown on the drawings, and required for proper system operation and maintenance.

2.4 DIELECTRIC FITTINGS

A. Dielectric insulating fittings shall be provided to connect dissimilar metals, such as copper tubing to ferrous metal pipe. Connections 2" and smaller shall be threaded dielectric union conforming to ANSI B16.39. Connections 2-1/2" and larger shall be flange union with dielectric gasket and bolt sleeves, conforming to ANSI B16.42. Insulating fittings will not be required between bronze

valves and copper piping, unless otherwise specified.

2.5 PIPE HANGERS AND SUPPORTS

A. All piping shall be rigidly supported from the building structure by means of hanger assemblies properly selected and sized for the application in accordance with the manufacturer's recommendations and specifications. Pipe hangers shall be Grinnell, B-Line, or equivalent.

B. No attempt has been made to show all required piping supports in all locations, either on the drawings or in the details. The absence of pipe supports and details on any drawing shall not relieve the Contractor of the responsibility for furnishing and installing proper hangers and supports throughout.

C. Piping hangers shall be spaced on the scheduled maximum spacing and shall have hangers not more than one foot from each elbow and other changes in direction or elevation. Provide additional hangers and supports at valves, strainers, in-line pumps adjacent to flexible connections, and other required heavy components. Piping system shall be installed in an approved manner and shall not overload the building structural frame. Contractor shall provide additional hangers and miscellaneous steel supports as may be required to distribute the piping system load over multiple structural members where required or directed. Maximum allowable spacing for steel and copper piping, other than fire protection piping, shall be as scheduled in Table No. 1.

TABLE NO. 1
MAXIMUM SUPPORT SPACING FOR STEEL
AND COPPER PIPING SYSTEMS

Steel Piping	- Maximum Spacing
1/2"	- 5'-0"
3/4" and 1"	- 6'-0"
1-1/4" through 2"	- 8'-0"
2-1/2" through 6"	- 10'-0"
8" through 12"	- 12'-0"
Copper Piping	**- Maximum Spacing**
1/2"	- 5'-0
3/4" through 2"	- 6'-0"
2-1/2" through 4"	- 8'-0"
5" and larger	- 10'-0"

D. Round rods supporting the pipe hangers shall be of the minimum dimensions as scheduled in Table No. 2. Hanger rods shall be hot-rolled steel, ASTM A-36 or A575, galvanized, all-thread. Provide for controlling level and slope by turnbuckles or other approved means of adjustment and incorporate locknuts.

TABLE NO. 2
HANGER ROD SIZE FOR PIPE HANGER SUPPORTS

1/2" to 2" pipe	- 3/8" rod
2-1/2" to 3" pipe	- 1/2" rod
4" to 5" pipe	- 5/8" rod
6" pipe	- 3/4" rod
8" to 12" pipe	- 7/8" rod

14" and 16" pipe	- 1" rod
18" and 20" pipe	- 1-1/4" rod
24" and 30" pipe	- 1-1/2" rod

E. Cast iron soil, waste and vent piping shall be provided with steel clevis type hangers. Grinnell Fig. 590 at each pipe joint and at each fitting.

F. Hanger spacing for plastic piping system support shall be as scheduled below in Table No. 3 for PVC and CPVC piping, based on pipe full of liquid with specific gravity of 1.0. See Table No. 5 for specific gravity correction factors. Piping may be continuously supported with a "V" or "U" shaped support made of metal or heat resistant approved plastic material. Hanger supports shall be in accordance with piping system manufacturer's recommendations.

TABLE NO. 3A
MAXIMUM SUPPORT SPACING FOR PVC AND CPVC PIPING SYSTEMS
SCHEDULE 40 PVC - MAXIMUM SPACING
OPERATING TEMPERATURE (DEGREE F)

	PVC AND CPVC			CPVC				
Size	60 & less	80	100	120	140	160	180	200
1/2" and 3/4"	5.5	5	4.5	4	3	3	3	2.5
1" and 1-1/4"	6	5.5	5.5	4.5	3.5	4	3.5	3
1-1/2" and 2"	6	6	5.5	4.5	3.5	4.5	4	3.5
2-1/2" and 3"	7.5	7	6.5	5.5	4.5	5.5	5	4
4"	8	7.5	7	6	4.5	6	5.5	4.5
5" and 6"	8.5	8	7.5	6.5	5	7	6	5
8"	9.5	9	8.5	7	5.5	7.5	6.5	5.5
10"	10	9	8.5	7	5.5	--	--	--
12"	10.5	10	9	8	6	--	--	--

TABLE NO. 3B
MAXIMUM SUPPORT SPACING FOR PVC AND CPVC PIPING SYSTEMS
SCHEDULE 80 PVC - MAXIMUM SPACING
OPERATING TEMPERATURE (DEGREE F)

	PVC AND CPVC			CPVC				
Size	60 & less	80	100	120	140	160	180	200
1/2"	6	6	5.5	4.5	3.5	3	2.5	2
3/4"	5.5	5	3.5	3	2.5	2		
1" and 1-1/4"	7	6.5	6	5	4	3.5	2	2.5
1-1/2" and 2"	7.5	7	6.5	5.5	4	4	3.5	3
2-1/2" and 3"	8.5	8	7.5	6.5	5	4.5	4	3
4"	9.5	9	8.5	7	5.5	5.5	5	3.5
5" and 6"	10	9	8.5	7	5.5	6	5.5	4
8"	11.5	11	10	8.5	6.5	6.5	6	4.5
10"	12.5	12	11	9.5	7	--	--	--
12"	13.5	13	12	10	8	--	--	--

TABLE NO. 5

SPECIFIC GRAVITY CORRECTION FACTOR FOR PLASTIC PIPING SYSTEMS

Specific Gravity:	1.0	1.1	1.2	1.4	1.6	2.0	2.5	
Correction Factor:		1.0	0.98	0.96	0.93	0.90	0.85	0.80

G. Fire protection system shall be supported in strict accordance with the requirements contained in the applicable NFPA pamphlets and as specified in Division 21, Fire Suppression Systems.

H. Hangers, clamps and other support materials in contact with copper piping shall be copper or copper plated to prevent electrolysis. Hangers for copper piping shall be copper plated adjustable ring type Grinnell Fig. CT-269, adjustable swivel ring, Grinnell Fig. CT69, Fig. CT-65 or adjustable clevis type or equivalent. Provide minimum 10 mil plastic wrap around copper pipe at any ferrous point of attachment including trapeze hangers, clamps, and other supports.

I. Hangers for steel shall be steel clevis type hangers, Grinnell Fig. 260 or equivalent.

J. Where piping is installed side by side, the Contractor may support the piping utilizing trapeze type hanger assemblies. Horizontal trapeze member shall be galvanized steel channel, not less than 1-1/2" x 1-1/2" x 12" gauge, or Unistrut. Contractor shall provide heavier steel members as required for the load to be supported and the distance span. Trapeze hangers shall not be utilized for fire and sprinkler piping and plumbing drain waste and vent piping. Hanger rods shall be as specified above, properly sized for the load supported but not less than 5/8" diameter. Uninsulated copper piping shall be isolated from the steel trapeze. Individual pipe shall be guided on the horizontal member at every other hanger point with 1/4" U-bolt fabricated from steel rod. Provide full circle galvanized sheetmetal insulation shield for insulated piping at trapeze hangers with U-bolt guide and galvanized sheetmetal insulation half-shield at other trapeze hangers. Insulation shield shall be 18 gauge minimum, Grinnell Fig. 167 or equivalent.

K. Where shown on the drawings and as required for the proper control of the system expansion and contraction piping, provide rolled type supports. Roller hangers shall be Grinnell Fig. 181 or equivalent and roll support for trapeze hangers and pipe racks shall be Grinnell Fig. 271 or equivalent complete with base plate.

L. Vertical piping shall be supported at each floor level by means of riser clamps, Grinnell Fig. 261 and Fig. G-121 copper clad for copper piping systems, or equivalent. Proper allowance for the expansion and contraction of the vertical risers shall be provided. Contractor shall submit shop drawings indicating proposed method for support and control of expansion and contraction of vertical piping.

M. The use of pipe hooks, chains, or perforated iron for pipe hanger supports will not be permitted.

N. All insulated piping systems specified in Section 22 0700, Plumbing Insulation and Section 23 0700, HVAC Insulation, shall be provided with individual hangers sized to encircle the insulation. See applicable sections for insulation thickness requirements. The specified piping systems where supported by means of trapeze hangers shall not rest directly on the trapeze horizontal members. The insulation at hangers and trapeze hangers shall be protected by means of insulation shield, Grinnell Fig. 167, or equivalent. Grinnell Fig. 160 or equivalent, curved steel pipe saddle, shall be provided at roll hangers. Contractor shall provide section of high density calcium silicate insulation or thermal hanger shields as manufactured by Pipe Shields, Inc., or equivalent, at all insulation piping system hanger and support points for piping 1-1/2" or larger.

O. Attachment of piping hangers to the building structure shall be provided in a manner approved by the Architect. The Contractor shall provide concrete inserts in the building construction at the time the concrete is poured and hangers shall be attached to these inserts. Self-drilling expansion anchors, Federal Specification FF-S-325, may be used in concrete construction not less than 4" thick. Applied load shall not exceed manufacturer's approved ratings. Power driven fasteners may be used in existing concrete or masonry not less than 4" thick where approved by the Architect. Attachment to steel construction shall be by means of beam clamps. Attachment to wood construction shall be by means of wood screws or lag bolts.

2.6 PIPE SLEEVES

A. Pipe sleeves shall be furnished and set by the Contractor and he shall be responsible for their proper and permanent location. Piping will not be permitted to pass through footings, beams or ribs except with written consent of the Architect. Pipe sleeves shall be installed and properly secured in place at all points where pipes pass through gypboard stud walls and concrete, and masonry construction and at all fire and smoke rated walls and partitions. Pipe sleeves, except sleeves in footings and beams shall be equal to Pipe Shields Incorporated Model WFB for walls, DFB for decks, or QDFB for corrugated decks, or equivalent. Each sleeve shall be adjustable, with annular spacing packed with UL approved mineral fiber fire safing material. Where insulated piping is installed, calcium silicate inserts to match the insulation thickness and extending 1" past the sleeve on both ends, shall be provided. Pipe sleeves in concrete and masonry construction, footings and beams shall be Schedule 40 black steel pipe. Pipe sleeves in gypboard construction shall be galvanized steel metal. Sleeves shall be not less than 1" or more than 2" larger in diameter than the pipe to be installed. Pipe sleeves in floors shall extend 2" above finished floor in chases and equipment room areas unless otherwise approved by the Architect. Openings between piping and sleeves shall be made watertight with plastic cement installed to a minimum depth of 2". Where pipes pass through exterior walls, the annular space between the wall and the pipe shall be sealed by sealing elements made of synthetic rubber, pressure plates, and cadmium plated bolts as manufactured by Link-Seal, or equivalent.

B. Uninsulated piping passing through fire walls, smoke wall, sound control walls and air plenum separations shall be sealed airtight to the adjacent construction by means of UL approved fireproof caulking materials.

C. Insulated piping passing through fire walls and smoke walls shall be provided with a section of UL approved fire safing insulation to match the required insulation thickness or Pipe Shields, Inc. pipe shield sleeves as specified above at the required wall penetrations. The space between the piping sleeve penetration and the adjacent wall Construction shall be sealed airtight with UL approved fireproof caulking material. Penetrations of gypboard sound walls and air plenum separators shall be caulked airtight with an approved caulking compound.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Provide and erect, according to the best practices of the trade, all piping shown on drawings and required for the complete installation of these systems. The piping shown on the drawings shall be considered as diagrammatic for clearness in indicating the general run and connections, and may or

may not in all parts be shown in its true position. The piping may have to be offset, lowered or raised as required or as directed at the site. This does not relieve the Contractor from responsibility for the proper erection of systems or piping in every respect suitable for the work intended as described in the specifications. In the erection of all piping, it shall be properly supported and proper provisions shall be made for expansion, contraction and anchoring of piping. All piping shall be cut accurately for fabrication to measurements established at the construction site. Pipe shall be worked into place without springing and/or forcing, properly clearing all windows, doors, and other openings and equipment. Cutting or other weakening of the building structure to facilitate installation will not be permitted. All pipes shall have burrs and/or cutting slag removed by reaming or other cleaning methods. All changes in direction shall be made with fittings. All open ends of pipes and equipment shall be properly capped or plugged to keep dirt and other foreign materials out of the system. Plugs of rags, wool, cotton waste or similar materials may not be used in plugging. All piping shall be arranged so as not to interfere with removal and maintenance of equipment or filters or devices; and so as not to block access to manholes, access openings, etc. Flanges or unions as applicable for the type of piping specified shall be provided in the piping at connections to all items of equipment including refrigeration machines. All piping shall be so installed to ensure noiseless circulation. All valves and specialties shall be so placed to permit easy operation and access, and all valves shall be regulated, packed and adjusted at the completion of the work before final acceptance. All piping shall be erected to ensure proper draining.

3.2 JOINTS

A. Caulked Joints: Caulked joints in hub-and-spigot piping and vent piping shall be packed firmly with white oakum, "Sealite No. 110," or hemp and caulked with pure molten lead not less than 1" deep. Resilient molded gasket joints or "Ty-Seal" may be used in lieu of lead and oakum for sanitary soil, waste and vent piping. No-hub pipe and fittings will be accepted with the exception that no-hub pipe and fittings shall not be allowed for buried installation.

B. Screwed Joints: Shall have American Taper pipe threads. Ream pipe ends and remove burrs after threading. Make up joints using Teflon tape or other approved compound applied to the male threads only.

C. Solder Joints: Copper tubing shall be cut square and burrs removed. Both inside of fittings and outside of tubing shall be well cleaned before sweating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connections. Joints for sweated fittings shall be made with a non-corrosive paste flux and solid 95-5 Tin-antimony wire solder, unless otherwise specified. Cored solder will not be permitted. 50/50 lead solder shall not be permitted for any applications.

D. Welded Joints: On black steel piping 2-1/2" and above in size, the joints may be welded. Welding shall be done using either gas or electric welding equipment. Certified welders shall be used. Welders shall be certified in accordance with Section IX of ASME Boiler and Pressure Vessel Code, latest edition. All pipe surfaces shall be thoroughly cleaned before welding. Each joint shall be beveled before being welded. Piping shall be securely aligned and spaced, and the width of circumferential welds shall form a gradual increase in thickness from the outside surface to the center of the weld. All fittings used in the welded piping systems shall be standard ASA fittings, and shall be of standard pipe thickness. The Contractor shall provide a fireproof mat or blanket to protect the structure and adequate fire protection at all locations where welding is done. The use of fittings formed from welded pipe sections will not be permitted.

E. Flanged Joints: Flanged joints shall conform to the American Standard for cast iron flanged pipe fittings, Class 125, 150 or 300 as specified in the applicable Sections of these specifications. Gaskets shall be full face or ring type, non-asbestos, suitable for the service on which used.

3.3 PUMP AND EQUIPMENT CONNECTIONS

A. All piping connecting to pumps and other equipment whether connected utilizing flexible connectors or with solid pipe connectors, shall be installed without strain at the pipe connection of the equipment. The Contractor shall be required, if so directed, to disconnect piping to demonstrate that piping has been so connected.

3.4 EXPANSION AND CONTRACTION

A. The Contractor shall make all necessary provisions for expansion and contraction of piping with offsets or loops and anchors as required to prevent undue strain. Contractor shall provide shop drawings for proposed method and arrangement for control of expansion and contraction of piping. See Section 230505 for expansion joints, expansion compensators, pipe guides and pipe anchors.

3.5 PROTECTIVE COATINGS

A. All underground steel pipe shall be wrapped with "Scotchwrap" No. 50 tape or equivalent, to give not less than two complete layers on the entire underground piping system, or piping shall have X-Tru-Coat factory applied plastic protective covering.

3.6 FLUSHING, DRAINING AND CLEANING PIPE SYSTEMS

A. The Contractor shall flush out all water systems with water before placing them in operation. Other systems shall be cleaned by blowing them out with compressed air or nitrogen. After systems are in operation and during the test period, all strainer screens shall be removed and thoroughly cleaned.

B. See applicable HVAC piping system specification sections for chemical cleaning of piping systems.

3.7 TESTING

A. Before any insulation is installed or before piping is covered or enclosed, all piping systems shall be tested and proven tight at not less than 150% of the maximum service pressure which the piping systems will be required to handle. Piping system tests shall be as specified in the applicable sections of this Specification. All tests shall be witnessed and approved by the Architect.

B. All labor, material, and equipment required for testing shall be furnished by the Contractor. The Contractor shall be responsible for all repairs and retesting as required. All instruments and other equipment whose safe pressure range is below that of the test pressure shall be removed from the line or blanked off before applying the tests. To perform tests, all lines shall be flushed and cleaned.

C. All safety measures required by codes or ordinances or reasonably applicable to the situation shall be provided by the Contractor in conjunction with the testing of the piping systems.

D. Equipment or piping to be pressure tested shall not be insulated, covered, or concealed prior to that test. Underground piping may be partially backfilled prior to pressure test when required for application of the test except that joints shall remain exposed until after the test. Tie rods, clamps etc., shall be in place and fastened.

E. Tests shall not be used to establish pressure ratings.

F. Protect all piping and equipment against over pressure, collapse from vacuum, and hydraulic shock during the filling, testing and draining procedures. Seats of iron valves shall not be subjected to a pressure in excess of the maximum cold working pressure of the valve. Pressure tests against other closed valves shall not exceed twice the normal rating.

G. Apply test pressure only after the system and test medium are at approximately the same temperature, preferably not less than 60^0F. Note that some applicable codes may require testing above a specified minimum temperature.

H. Remove from the system all pumps, turbines, traps, expansion joints, instruments, control valves, safety valves, rupture discs, orifice plates, etc., which might be damaged by the test. Also remove all items such as orifice plates which might trap air in a system to be hydrostatically tested. Disconnect all instruments and air lines where copper tubing starts.

I. Systems may be separated into sub-systems for testing if such action will expedite or simplify the testing.

J. During hydrostatic testing of lines, provide temporary supports to prevent overstressing supports or hangers. When tests are completed, remove all temporary supports, locks, stops, etc., and adjust supports for their cold load and alignment.

END OF SECTION 23 0504

SECTION 23 0505 - PIPING SPECIALTIES

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Contractor shall furnish and install all piping specialties necessary for satisfactory operation of the systems. Conform with applicable provisions of the General Conditions, Supplementary Conditions and General Requirements.

1.2 RELATED SECTIONS

A. Section 23 0500 for Common Work Requirements for HVAC.

B. Section 23 0504 for Pipe and Pipe Fittings.

C. Section 23 0523 for Valves.

D. Section 23 0700 for HVAC Insulation.

E. Section 23 0549 for HVAC & Electrical Installation Coordination.

1.3 SUBMITTAL DATA

A. Contractor shall furnish complete submittal data for all piping specialties including manufacturer's specifications, performance characteristics, ratings, installation instructions, certifications and approvals of listing agencies, wiring diagrams, and selection analysis.

PART 2 - PRODUCTS

2.1 STRAINERS

A. Strainers suitable for the application shall be furnished and installed on the high pressure side of pressure reducing valves, pressure regulating valves, suction side of pumps, inlet of indicating and control instruments and equipment subject to sediment damage, and as shown on the drawings. Strainers shall be "Y"-type unless basket strainers are indicated. Tee-type strainers will not be accepted. Strainer element shall be removable without disconnecting piping. Screens shall be Type 304 stainless steel with 1/8 inch perforations for water service, and 1/16 inch perforations for air and gas services. Every strainer shall be provided with a blow-off connection not less than 1/2" NPT and provided with a ball valve the full size of the strainer outlet tapping. Strainers located outside of mechanical equipment rooms and above ceilings shall be provided with hose connection and cap on the outlet of the blowoff valve. Strainers shall be Spirax Sarco, Armstrong, Febco, Grinnell, Hoffman, Keckley, Metraflex, Mueller, Yarway, or equivalent.

B. Strainers 2" and under for copper piping systems shall be threaded connection, bronze body, 250 PSIG maximum working pressure, suitable for steam, oil, gas and liquid service, Sarco BT or equivalent.

C. Strainers 2" and under for steel piping systems shall be threaded connection, bronze body, as specified above or cast iron body as specified herein, except all strainers in galvanized steel domestic water systems shall be bronze body. Cast iron strainers shall be threaded connection, 250 PSIG maximum working pressure, suitable for steam, oil, gas and liquid service, Sarco IT or equivalent.

D. Strainers 2-1/2 inches or larger shall be standard flanged connection ANSI-125, cast iron body, suitable for steam, oil , gas, and liquid service, 125 maximum working pressure at 353^{o} F maximum temperature, Sarco CI-125.

E. Basket strainers 2" and larger shall be standard flanged ANSI-125, cast iron body bolted cover, Type 304 stainless steel screen, suitable for steam or liquid service, 125 maximum working pressure at 353^{o}F maximum temperature, Sarco 528-B-125.

2.2 SUCTION DIFFUSERS

A. Suction diffusers shall be furnished and installed at the suction of pumps where indicated on the drawings. Suction diffuser outlet shall be not less than pump suction size and suction diffuser system inlet shall be a minimum of one size larger than suction diffuser outlet size. Suction diffuser shall provide for a smooth flow of water into the pump inlet, and shall be complete with strainer, adjustable support leg, and start-up strainer. Start-up strainer shall be removed at the final testing and balancing phase.

2.3 PRESSURE GAUGES

A. Pressure gauges for water, non-corrosive liquids, and gases shall be Weiss Series UG-1, Style B, Marshalltown, Ashcroft, Trerice, Weksler, or equivalent. Gauges shall be 4-1/2 inches diameter, unless otherwise indicated, aluminum case with no back flange, black enamel finish, aluminum threaded ring, aluminum dial with white background and black lines and numerals, bronze bourdon tube with brass socket and 1/4 inch NPT bottom connection. Accuracy shall be 1/2 of 1% of full scale range, minimum.

B. Pressure range shall be indicated on the drawings or if not indicated shall be selected so that the normal operating pressure is approximately 50% of the scale range. Provide compound and vacuum ranges when required by the application.

C. Provide brass pressure snubber for all gauges with properly selected filter disc for the application. Provide a brass ball valve for each gauge. Where a single gauge is shown with multiple pressure sensing points, such as pump suction, discharge and strainer pressure drop applications, provide a gauge valve for each pressure sensing point.

D. Gauges shall be field calibrated as required to provide accurate readings.

E. Gauges shall be installed in such a manner as to be easily readable from ground level. This shall include piping to an adjacent location and mounting gauges on wall or frames where required.

2.4 THERMOMETER AND THERMOMETER WELLS

A. Thermometers shall be Weiss, Moeller, Trerice, Duro, or equivalent, 9" case, straight form, back angle, or vari-angle arrangement as required by the installation requirements. Cases shall be V-shaped design, high pressure die cast aluminum, baked enamel finish, with heavy glass protected front firmly secured with spring action. Tube and capillary shall be mercury filled-magnifying lens "red reading" with accuracy of 1% of scale range, minimum. Stem shall be 3-1/2" for piping sizes through 6", and 6" for piping sizes 8" and larger. Provide stainless steel separable sockets sized for stem lengths required for the applications. Extension neck separable sockets shall be provided for installation in conjunction with insulated piping systems.

B. Thermometer scale ranges shall be as indicated on the drawings or if not indicated shall be selected as required for the services. Typical ranges shall be as follows:

Heating water (low temperature 120^{o}F, maximum)	0 - 160 degrees F
Heating water (above 120^{0}F)	30 - 240 degrees F
Domestic cold water	0 - 120 degrees F
Domestic hot water	30 - 180 degrees F

C. Thermometers shall be field calibrated as required to provide accurate readings.

D. Thermometers shall be installed in such a manner as to be easily readable from ground level. Provide vari-angle thermometers as necessary to meet this requirement.

2.5 MANUAL AIR VENTS

A. Provide manual air vents at locations indicated on the drawings, at the high point of all liquid piping system and as otherwise required for proper air elimination and liquid circulation.

B. Manual air vents shall be 1/2" brass ball valves as specified in Section 230523. Provide brass hose connection and plug on valve outlet.

2.6 AUTOMATIC AIR VENT

A. Provide automatic air vents for all separators, at the high point of all hydronic systems and at locations indicated on the drawings. Automatic air vents shall be 3/4" size, minimum. Provide manual shut-off ball valve between automatic air vent and piping system. Automatic air vents shall be float type, 150 PSIG maximum working pressure, 3/4" NPT system connection, Amtrol Model No. 720, Taco, Armstrong, Watson-McDaniel, Hofmann, or equivalent.

2.7 MANUAL DRAIN VALVES

A. Provide manual drain valves at locations indicated on the drawings, at the low points of all liquid piping systems, and as otherwise required for proper draining of systems. Manual drain valves shall be sized as shown on the drawings but not less than 3/4" size, brass ball valve, as specified in Section 230523. Pipe discharge from drain valves to floor drain, floor sink, or as otherwise directed for indirect discharge into sanitary sewer system. For drain valves located above ceiling or in location outside mechanical equipment areas provide brass hose connection and cap for valve discharge.

2.8 TEMPERATURE AND PRESSURE TEST PLUGS

A. Where shown on the drawings, and on the inlet and outlet of each coil, heat exchanger, heating and cooling water generating equipment, heat rejection equipment and heat recovery equipment and 3-way control valve, furnish and install temperature and pressure test plugs with Nordel valve cores and 1/2" NPT brass body with gasketed cap. Test plugs shall be Peterson Equipment #110, or equivalent. The combination pressure temperature test wells shall be a minimum of 1/2" standard pipe thread.

2.9 FLOW BALANCE VALVE

A. Furnish and install calibrated balance valve equivalent to Bell and Gossett "circuit-setter," Griswold, Taco, Armstrong, or equivalent at locations indicated on the drawings. Balance valves shall be brass or cast iron body, NPT or sweat connections through 3" size and flanged connections above 4" size, 125 PSIG working pressure minimum. Balance valve shall be equipped with two brass readout valves with integral EPT insert and check valve designed to minimize system fluid loss during balancing and monitoring process. Each valve shall be provided with a calibrated nameplate permitting accurate system balance. Flow balance valves shall be not less than full line size with maximum pressure drop of 10 feet.

2.10 WATER FLOW MEASURING DEVICES

A. Furnish and install cast iron wafer type flow meter equivalent to Bell & Gossett "OP-Series, "Griswold, Taco, Armstrong, or equivalent at locations indicated in the drawings. Flow meters shall be equipped with two brass readout valves with integral EPT insert and check valve designed to minimize system fluid loss during monitoring process. Flow meter shall be furnished with a calibrated nameplate specifying the flow range through a range of differential pressures. Water flow measuring devices shall be not less than full line size with maximum pressure drop of 10 feet.

2.11 AUTOMATIC FLOW CONTROL VALVES

A. Furnish and install constant flow control valves Griswold or equivalent at locations indicated on the drawings. Automatic flow control valves shall be factory calibrated to maintain constant flow within 5% over system pressure fluctuations of at least ten (10) times the minimum required for control. Flow control valves shall be cast iron body with stainless steel cartridges, two pressure readout ports with quick disconnect valves, metal identification tag attached to valve marked with rated flow GPM. Valves through 2-1/2" size shall be threaded connection, valves over 3" shall be wafer type for mounting between flanges furnished and installed by the Contractor. Automatic flow control valves shall be 150 PSIG minimum working pressure.

2.12 TRIPLE DUTY VALVE

A. At the Contractor's option, triple duty valve as manufactured by Bell & Gossett or equivalent may be utilized at pump discharge in lieu of non-slam check valve and balance/shut-off valve. Triple duty valve shall incorporate non-slam check valve with spring-loaded weighted disc and a calibrated adjustment feature permitting regulation of pump discharge flow and shut-off. Valves shall be designed to permit re-packing under full line pressure. Unit shall be installed on discharge

side of pump in a horizontal or vertical position with the stem up. Unit shall be cast iron body construction suitable for maximum working pressure of 175 PSIG and maximum operating temperature of 300°F, bronze disc and seat, stainless steel stem and spring.

2.13 FLEXIBLE CONNECTORS

A. Furnish and install flexible connectors at locations indicated on the drawings and at all piping connections associated with equipment mounted on or hung from vibration isolators. Flexible connectors shall be constructed of multiple ply nylon cord fabric and neoprene, operating pressure 150 PSIG at 220°F through 12" size and operating pressure of 125 PSIG at 220°F for sizes 14" through 24". Provide butyl or Hypolon liner and applications with fluid temperatures in excess of 225°F.

B. Flexible connectors shall be single or twin sphere with Class 150 flange connections for sizes 2-1/2" and larger and threaded connections with galvanized female unions for sizes 3/4" through 2". Mason Industries MFTCR, Hyspan, Metra-Flex, Keflex, Proco, or equivalent. Flexible connectors required for outdoor installation shall be braided stainless steel type.

C. Installation of flexible connectors shall be in strict accordance with manufacturer's recommendations. Spacing between piping system flanges shall be based on the flexible connector's expanded length corresponding to the system's operating pressure. Control rods or cables shall be provided for units installed in unanchored applications where system operating pressure and dynamic forces exceeds manufacturer's recommendations for unrestrained installations.

D. For piping systems utilizing grooved pipe with mechanical couplings, flexible connectors consisting of a minimum of three (3) stacked couplings, equivalent to Victaulic Style 75, between 6" long grooved nipples may be substituted for the neoprene units specified herein.

2.14 PUMPS

A. End suction pumps: horizontal, end suction, frame mounted, flexibly connected cast iron bronze fitted with casing rings, 316 stainless steel shaft sleeves and mechanical seal. Casing shall have a minimum working pressure of 125 PSIG. Impeller shall be single suction enclosed type of bronze construction. Shaft shall be high strength 1045 carbon steel. Bearing frame shall be cast iron construction provided with catch basin reservoir with tapped drain hole to collect and pipe away mechanical seal leakage. Base plate shall be factory fabricated steel sufficiently rigid to support the ensemble and to keep the coupling aligned; baseplate shall be drip-lip design with tapped hole to pipe away leakage and condensation. Motors shall be high performance 5 hp and larger. Pumps shall have mechanical seals. Furnish coupling guard. Allis Chalmers, Bell & Gossett, Aurora, Weinman, Peerless, Worthington, Armstrong, Dunham Bush, Pacific, Taco, or equivalent.

B. In-line recirculating pumps: Cast iron body, bronze fitted, with mechanical seal. Motor shall be 1750 RPM for use with 115 volt current. Bell & Gossett, Thrush, Taco, Armstrong, or equivalent.

2.15 EXPANSION TANK

A. Furnish and install diaphragm type, pre-pressurized, ASME code construction 125 PSIG working pressure, expansion tank in horizontal or vertical arrangement as shown on the drawing and required for equipment space allocation. Properly sized expansion tanks shall be provided for all closed circuit hydronic systems. Connect expansion tank to the low pressure side of the piping system with 3/4" minimum line size, provide quarter-turn ball valve with handle removed for manual isolation valve. Contractor shall field verify expansion tank air charge and re-charge as required to maintain correct system pressurization and tank expansion volume. Expansion tanks shall be Amtrol, Woods, Armstrong, Taco, or equivalent.

2.16 AIR/DIRT SEPARATOR

A. Furnish and install as shown on the drawings and schedule a full flow coalescing type dirt separator for the condenser water system. Selection shall be based upon system flow with pipe size as a minimum in accordance with the basis of design. In no case shall entering velocity exceed 10 feet per second. Separator shall be fabricated steel and rated for 150 psig working pressure. The vessel diameter and distance below the inlet / outlet connections must be equal to the basis of design. Unit shall include internal Spirotube® elements filling the entire vessel to suppress turbulence and provide minimum dirt separation efficiency of 80% of all particles 30 micron and larger within 100 passes. The elements must consist of a copper core tube with continuous wound copper wire medium permanently attached and followed by a separate continuous wound copper wire permanently affixed. A system strainer shall be installed upstream ahead of the dirt separator to catch all large material that may have been left in piping during construction. Include removable lower head for internal inspection.

B. Basis of design for the dirt separator shall be the Spirotrap® Series TDT or THT as manufactured by Spirotherm, Inc., Glendale Heights, Illinois or approved equal.

2.17 WATER PRESSURE REGULATING VALVES

A. Furnish and install water pressure regulating valves, Watts U5B, Bell & Gossett, Amtrol, Cash, Jordan, or equivalent, 3/4" size minimum for water makeup to all hydronic systems and at other locations as shown on the drawings. Water pressure regulating valves shall be brass body, union inlet with integral strainers, 300 PSIG maximum working pressure, with built-in thermal expansion bypass.

B. For high water capacity applications provide Watts 2235B, Bell & Gossett, Amtrol, Cash, Jordan, or equivalent.

C. Provide high or low pressure range depending on application requirements. Set pressure shall be as shown on the drawings, or as required to provide a minimum system pressurization of 12 PSIG at the system's highest point for closed circuit hydronic systems, or as recommended by equipment manufacturers.

2.18 WATER PRESSURE RELIEF VALVES

A. Furnish and install ASME labeled, National Board Stamped, water pressure relief valves, Watts Series 174A or 740, Bell & Gossett, Amtrol, Cash, Jordan, or equivalent, 3/4" size minimum for relief of all water makeup to all closed circuit hydronic systems. Properly sized relief valves shall

be provided where required for over-pressure protection on heat exchangers, converters, boiler, and pressure vessels, and other locations as shown in the drawings.

B. Relief valves shall be sized for the full system heating capacity, to match the makeup capacity, or as otherwise required to protect the system from over-pressure conditions. Relief valves shall be factory pre-set for maximum pressure rating shown in the drawings, or for approximately 125% of the system operating pressure, but in no case shall the relief valve setting exceed the maximum safe operating pressure of the system and system components and equipment.

2.19 WATER TEMPERATURE AND PRESSURE RELIEF VALVES

A. Furnish and install ASME labeled, National Board stamped water temperature and pressure relief valves, Watts, Cash, or equivalent, for all domestic water heaters, domestic water storage tanks, and other locations indicated in the drawings.

B. Water temperature and pressure relief valves shall be sized for the full system heating capacity at 210^{o}F maximum operating temperature and shall be furnished with the required valve thermostat tube extension length.

2.20 WATER REDUCED PRESSURE BACKFLOW PREVENTERS

A. Furnish and install water reduced pressure backflow preventer, as approved and accepted by the City of Las Cruces, State of New Mexico, Febco Model 825Y, Hersey, Beeco, Watts, or equivalent. 3/4" minimum size shall be provided for water makeup to all required HVAC systems. Backflow preventers shall be provided at other locations as shown on the drawings. Reduced pressure backflow preventer shall include two shut-off gate or ball valves, two check valves, pressure relief valve, and four test cocks. Units shall be factory assembled, tested and certified. Units 2" and smaller shall be brass body, threaded connections, 175 PSIG maximum working pressure. Units 2-1/2" and larger shall be provided with flanged connections.

B. Water reduced pressure backflow preventer installation shall be in accordance with manufacturer's instructions and City of Farmington, State of New Mexico requirements for access for testing and inspection.

C. See Division 22, for backflow protection associated with site water supply system.

D. See Division 22 for backflow protection associated with building domestic water supply system.

E. See Division 21 for backflow protection associated with building fire protection system.

F. Backflow protection devices associated with landscaping and irrigation systems shall be furnished and installed under the Site Work sections of these specifications.

2.21 WATER TREATMENT

A. Water treatment for hydronic systems shall be provided as listed on the equipment schedule, shown on the drawings, and specified under the applicable piping system Sections of this specification.

2.22 FLOW METERS AND INSTRUMENTATION

A. Water meters and instrumentation shall be furnished and installed as shown on the drawings and specified in Section 23 0900.

2.23 SOLENOID VALVES

A. Furnish and install electric solenoid valves as shown on the drawing and as required for the operation of the mechanical systems. Solenoid valves shall be 115 volt single phase, 60 Hz, two-way arrangement, two positions with normally open or normally closed arrangement as required of the application. Solenoid valves associated with safety protection of systems including freeze-protection, drain down, etc. shall be provided such that in the event of a power failure the system shall fail to a safe operating condition. Solenoid valves shall be as manufactured by ASCO, Armstrong, Honeywell, Metrex, or equivalent.

B. Furnish hazardous duty enclosure where required by the application.

2.24 FLOW SWITCHES

A. Furnish and install flow switches where required for protection and/or monitoring of mechanical equipment including water chillers, boilers pumps, etc. and as otherwise shown on the equipment schedule, and the drawings.

B. Flow switches shall be either paddle type or differential pressure type as required by the application and as shown on the drawings, except differential pressure type flow switches shall be utilized for water chillers and other applications where minor pressure fluctuation could cause nuisance tripping of equipment operation.

1. Paddle type flow switch shall be McDonnell and Miller Model FS7-4 Series, or equivalent designed for industrial duty, brass body and trim, 300 PSIG maximum working pressure, paddle size as required for application, single pole double throw switches, with electrical rating of 7.4 full load amps at 115 VAC. Provide hazardous duty enclosure where required by the application. Flow switches shall be installed in a horizontal pipe with inlet and outlet conditions necessary to provide trouble-free operation.

2. Differential pressure flow switch shall be Honeywell Model 406 Series or equivalent, adjustable pressure differential setting, dustproof mercury switch enclosure, 1/4" NPT bellows connections, single pole, single throw switch, with electrical rating of 7.2 full load amps at 115 vac. Differential pressure switches shall be properly supported on the equipment controlled or wall mounted adjacent to the equipment or piping system.

2.25 ELECTRICAL HEAT TRACING SYSTEM

A. Furnish and install electric heat tracing system for winterizing protection for all liquid piping systems exposed to the outdoor ambient environment and piping systems in the unheated areas of the building.

B. Heating cable shall be self-regulating rapid trace, Type SRL, low temperature, heating cable rated at 150°F maximum maintenance temperature and suitable for 185°F maximum exposure temperature, or type SRM medium temperature heating cable rated at 250°F maximum maintenance temperature and suitable for 375°F maximum exposure temperature, as required by the application and as manufactured by Chromolux or equivalent. Heating cable shall be flexible, parallel circuit construction consisting of a continuous self-limiting resistance, conducive inner core material between two parallel copper bus wire, designed for cut-to-length at the job site by the Contractor and suitable for wrapping around piping valves and complex fittings. Self-regulation shall prevent overheating and burnouts even where the cable overlaps itself. Provide end seals for ends of circuits. Wire at the ends of circuits shall not be tied together.

C. Heating Tracing System shall be furnished with all accessories required for the complete installation including the power supply connection fitting and stainless steel mounting brackets with stainless steel worm gear clamp to fasten bracket to pipe, 1/2 inch wide fiberglass reinforced pressure sensitive cloth tape as required to fasten cable to pipe at not greater than 12 inch intervals. Furnish pipe surface temperature control thermostat with capillary and copper bulb sensor, cast aluminum NEMA (water- tight) enclosure, 1/2 inch NPT conduit hub, SPST switch with required rating at 115 VAC through 5 KW systems capacity and 120 volt single phase, 60 HZ for system heating capacities in excess of 5 kW. Set thermostat to maintain pipe surface temperature at not less than 34^{0}F. Furnish and install piping labels on systems with electric heat tracing, manufacturer's standard (NEC code), labeled or stamped "ELECTRIC TRACED" labels shall be installed on the insulation pipe jacket at 10 foot intervals along the pipe on alternating sides.

D. Electric Heat tracing system sizing shall be provided as recommended by the manufacturer to maintain pipe surface temperature at 34°F minimum during the winter outdoor design temperature of 0°F with 15 MPH wind velocity, and the normal system fluid operating temperature. See Section 230523, HVAC Insulation for insulation characteristics and thickness associated with electrical heat traced systems. Piping system insulation shall be oversized as required to accommodate the heating cable.

2.26 EXPANSION JOINTS

A. Furnish and install corrugated bellows expansion joint, Hyspan Series 1500, Metra-Flex, Keflex, Proco, Flexonics, or equivalent, self-equalizing, 150 PSIG working pressure at 850°F, Class 150 ASA flange connections 1-1/2" size and above, single or dual center base configuration as shown on the drawings, constructed of corrugated Type 304 or 321 stainless steel, ring controlled, with integral stainless steel or Monel sleeve, and removable carbon steel external housing to protect bellows and support insulation. Furnish limit rods to prevent expansion joint from exceeding rated travel. Joint design shall be for maximum flexibility over 10,000 cycles minimum.

B. Expansion joint sizing and installation shall be as shown on the drawing and as recommended by the manufacturer.

C. Expansion joints shall be insulated with flexible 2" minimum thickness of high temperature fiberglass blanket insulation furnished with joint and installed under the external protective housing.

D. Contractor shall carefully check expansion joint limit rods and make adjustments as required to ensure proper joint movement and operation.

2.27 EXPANSION COMPENSATORS

A. Furnish and install expansion compensators, Hyspan series 8500, Metra-Flex, Keflex, Proco, Flexonics, or equivalent, stainless steel laminated bellows with stainless steel or carbon steel shroud, 175 PSIG pressure rating at 250^0F, 2 inch straight line expansion and 1/2 inch contraction. Furnish copper tube with sweat ends for compensators installed in copper piping systems. Furnish standard wall carbon steel pipe tube for compensators installed in steel piping systems, threaded connectors for sizes 2" and smaller and Class 150 ASA flange connection for sizes 2-1/2" or larger.

B. Expansion compensators sizing and installation shall be as shown on the drawings and as recommended by the manufacturer.

2.28 PIPE ALIGNMENT GUIDES

A. Furnish and install factory fabricated steel pipe alignment guides, Hyspan Series 9500, Metra-Flex, Keflex, Proco, Flexonics, or equivalent, to maintain the longitudinal position of pipe centerline between expansion joints and compensators with axial restraint. Alignment guides shall consist of a bolted two-section outer cylinder and base with two-section guiding spider bolted tight to the pipe guide. Guide and spider shall be sized to clear pipe and pipe insulation and long enough to prevent over travel of spider and cylinder. Guides shall not be used for pipe support.

B. Alignment guides shall be arranged and installed as shown on the drawings and as recommended by the manufacturer.

2.29 PIPE ANCHORS

A. Pipe anchors shall be constructed of welded steel as detailed on the drawings. Pipe anchors shall be attached to the building structure in a manner approved by the Architect.

B. Pipe anchors shall be arranged as shown on the drawings and as required to properly control/piping system expansion and contraction in conjunction with system flexibility due to off-sets, bends, and loops and expansion joints and compensators.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All specialties shall be installed in accordance with the best standard practices and as recommended by the manufacturer.

B. Where thermometers, gauges, vents and test fittings occur in insulated piping systems or on insulated equipment, extension necks shall be provided to extend beyond the insulation.

3.2 AIR VENTS

A. Manual air vents shall be installed as specified herein and at the high points in all piping systems.

B. Automatic air vents shall be installed as specified herein and at locations indicated on the drawings. Automatic air vents shall be installed level and in accordance with manufacturer's directions to properly vent system, complete with individual isolation valves.

3.3 STRAINERS

A. All strainer screens, including basket strainers and suction diffusers, shall be removed and cleaned prior to commencing testing and balancing work and shall be maintained clean through project final acceptance by the Owner. Suction diffuser start-up strainers shall be removed prior to final system testing and balancing work.

3.4 TEST AND ADJUSTMENT

A. Contractor shall field adjust all water pressure regulating valves, flow switches, water level controls, and specialties to provide required system operation.

B. Contractor shall field test and verify the operation of all safety devices including water relief valves and temperature and pressure relief valves.

3.5 RELIEF VALVE DISCHARGE

A. Water pressure relief valve and water temperature and pressure relief valve discharges shall be piped full size to the outside of the building or discharged indirectly in a properly sized building floor drain or floor sink, and as allowed by the Building Mechanical and Plumbing Codes. When the operating discharge temperature is in excess of 212^{o}F, the discharge shall be equipped with a splash shield or centrifugal separator.

B. Water reduced pressure backflow preventer discharge shall be piped full size to the outside of the building or discharged indirectly into a properly sized building floor drain or floor sink as allowed by the Building Mechanical and Plumbing Codes. Provide a bronze air gap funnel with stainless steel fasteners for installation under reduced pressure backflow prevention relief valve. Febco Model AGD or equivalent, 1" discharge pipe size for backflow preventer size through 2".

END OF SECTION 23 0505

SECTION 23 0523 - VALVES

PART 1 - GENERAL

1.1 REQUIREMENTS

A. All Valves shall conform with current applicable provisions of the General Conditions, Supplementary Conditions, and General Requirements.

B. All Valves shall meet the current MSS Specifications covering Bronze & Iron Valves. MSS-SP-80, MSS-SP-70, MSS-SP71, MSS-SP-85 where applicable.

C. Lead Ban: Valves shall be lead free. The term lead free is defined as valves which do not contain more than 8.0% lead.

1.2 RELATED SECTIONS

A. Section 23 0500 for Common Work Requirements for HVAC.

B. Section 23 0500 for Valve Identification.

C. Section 23 0504 for Pipe and Pipe Fittings.

D. Section 23 2119 for valves associated with underground pre-insulated piping systems.

E. Section 23 0900 for Automatic Temperature Control Valves.

F. Division 21, for fire suppression system valves and tamper switches.

G. Division 22, for plumbing system.

1.3 SCOPE

A. Contractor shall furnish and install all valves and accessories necessary for satisfactory operation of the systems.

1.4 VALVE REQUIREMENTS

A. All Gate, Globe, Check, Ball valves shall be manufactured by Milwaukee, Nibco, Apollo, Stockham, Powell, Crane, Grinnell, or equivalent.

B. All lubricated plug valves shall be as manufactured by Rockwell, Walworth, Homestead, or equivalent.

C. Butterfly valves shall be as manufactured by Milwaukee, W. C. Norris, Centerline, Crane, Demco, Keystone, Grinnell, Victaulic, Nibco, or Dezurik, or equivalent. Butterfly valves may

be used for closed circuit chilled water, heating hot water (200°F maximum) run-around coil and heat pump circulating water systems and for condensing water systems. Butterfly valves shall not be used for domestic water or other non-specified service.

D. Ball valves shall be utilized in lieu of gate valves and globe valves for all HVAC and plumbing systems for sizes 2" and smaller.

E. Butterfly valves may be substituted for gate, globe and ball valves for specified services, and for other services as may be approved by the Architect.

F. All valves furnish under Division 22 and 23, of the same type, shall be products of a single manufacturer unless otherwise approved by Owner's Representative.

G. Provide gate and globe valves with packing that can be replaced with the valve under full working pressure.

H. Provide chain operators for valves 4" and larger installed within mechanical equipment spaces where valves center line is in excess of eight feet above the floor or operating platform and as otherwise indicated on the drawings.

PART 2 - PRODUCTS

2.1 GENERAL SERVICE VALVES, HVAC AND PLUMBING SYSTEMS

A. Gate Valves - 2" and Smaller, Class 125: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 125 construction, solid disc, rising stem, gland packed, non-asbestos packing. Milwaukee 148 (Threaded), or equivalent; Milwaukee 149 (Solder), or equivalent.

B. Gate Valves - 2" and Smaller, Class 150: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 150 construction, solid wedge disc, rising stem, union bonnet, gland packed, non-asbestos packing. Milwaukee 1151 (Threaded), or equivalent; Milwaukee 1169 (Solder), or equivalent

C. Gate Valves - 2" and Smaller, Class 300: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 300 construction, solid wedge disc, rising stem, union bonnet, gland packed, non-asbestos packing. Milwaukee 1184 (Threaded), or equivalent.

D. Gate Valves - 2-1/2" and Larger, Class 125: Valves 2-1/2" and larger shall be of ASTM A-126 Class B cast iron, flanged ends, Class 125 construction, OS & Y Type, rising stem, bronze trim, non-asbestos packing. Milwaukee F2885, or equivalent.

E. Gate Valves - 2-1/2" and Larger, Class 250: Valves 2-1/2" and larger shall be of ASTM A-126 Class B cast iron, flanged ends, Class 250 construction, OS & Y Type, rising stem, bronze trim, non-asbestos packing. Milwaukee F2894, or equivalent.

F. Globe Valves - 2" and Smaller, Class 125: Valves 2-1/2" and smaller shall be of ASTM B-62, Class 125 construction, bronze trim, gland packed, non-asbestos packing. Milwaukee 502 (Threaded), or equivalent; Milwaukee 1502 (Solder), or equivalent.

G. Globe Valves - 2" and Smaller, Class 150: Valves 2" and smaller shall be of ASTM B-62,

bronze, Class 150 construction, bronze trim, composition disc, union bonnet, gland packed, non-asbestos packing. Milwaukee 590 (Threaded), or equivalent; Milwaukee 1590 (Solder), or equivalent.

H. Globe Valves - 2" and Smaller, Class 300: Valves 2" and smaller shall be of ASTM B-62, bronze, Class 300 construction, bronze trim, union bonnet, gland packed, non-asbestos packing. Milwaukee 572 (Threaded), or equivalent

I. Globe Valves - 2-1/2" and Larger, Class 125: Valves 2-1/2" and Larger shall be of ASTM A-126, Class B cast iron, flanged ends, Class 125 construction, bolted bonnet, gland packed, non-asbestos packing. Milwaukee F2981M, or equivalent.

J. Globe Valves - 2-1/2" and Larger, Class 300: Valves 2-1/2" and larger shall be of ASTM A-126, Class B cast iron, flanged ends, Class 300 construction, bolted bonnet, gland packed, non-asbestos packing. Milwaukee F2983, or equivalent.

K. Check Valves - 2" and Smaller, Class 125: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 125 construction, Y-pattern, swing type design, teflon seat, disc for steam service, Buna-N for water service. Milwaukee 509 (Threaded), or equivalent; Milwaukee 1509 (Solder), or equivalent.

L. Check Valves - 2" and Smaller, Class 150: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 150 construction, Y-pattern, swing type design, bronze seat, composition disc, teflon seat disc for steam service, Buna-N for water service. Milwaukee 510 (Threaded), or equivalent; Milwaukee 1510 (Solder), or equivalent.

M. Check Valves - 2" and Smaller, Class 300: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 300 construction, Y-pattern, swing type design, bronze regrinding disc. Milwaukee 507 (Threaded), or equivalent.

N. Check Valves - 2 1/2" and Larger, Class 125: Valves 2-1/2" and larger shall be of ASTM A-126 Class B, cast iron, flanged ends, Class 125 construction, bolted bonnet, bronze trim, swing type design. Milwaukee F2974M, or equivalent.

O. Check Valves - 2 1/2" and Larger, Class 250: Valves 2-1/2" and larger shall be of ASTM A-126 Class B, cast iron, flanged ends, Class 250 construction, bolted bonnet, bronze trim, swing type design. Milwaukee F2970, or equivalent.

2.2 BUTTERFLY VALVES

A. Valves 2-1/2" and larger shall be full lug pattern, ASTM A-216, Class B cast iron body, 416-SS stems, aluminum/bronze disc, EPDM liner and seats (-30°F to 275°F) w/rigid phenolic cartridge, 200 PSIG working pressure with Bubble tight shut-off. Valves shall be for mounting between flanges with lugs drilled and tapped so that pipe may be disconnected on either side of valve with opposite end remaining under pressure. Milwaukee ML-123-E or equivalent.

B. Valves 4" and smaller shall be provided with level handler operator with spring loaded lock stops. Valves 5" and larger shall be furnished with manual gear operator with hand wheel.

C. Valves installed for insulated services shall be provided with extensions, as required, such that

operator does not interfere with insulation or insulation jacketing.

D. Butterfly valves furnished for use in grooved piping system shall meet the material specification requirements as specified herein.

2.3 BALL VALVES

A. Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 150 construction, 600 PSI W.O.G. Two-piece body, chrome plated ball, blowout proof stem, reinforced TFE seats, non-asbestos packing. Milwaukee BA-100 (threaded) or equivalent. Milwaukee BA-150 (solder) or equivalent.

B. Valves installed on insulated services shall be provided with extensions, as required, such that operator does not interfere with insulation or insulation jacketing. Cutting or notching of the insulation or bending of handles shall not be permitted.

2.4 BALANCE VALVES

A. Valves 2" and smaller: Ball valve, bronze, Class 150 construction, 600 PSI W.O.G., Two piece body, Milwaukee BA-100 (threaded). Milwaukee BA-150 (soldered), as specified herein, or equivalent.

B. Valves 2-1/2" and larger: Lubricated plug valve, cast iron construction, 175 PSI W.O.G., Class 125 flange connections, level handle for valves 4" and smaller, manual gear operator with handle wheel for valve 5" and larger. Walworth No.1797F, or equivalent.

C. Valves 2-1/2" and larger:

1. Butterfly valve, full lug pattern, as specified herein.

2. Furnish level handle with infinite throttling positions and locking device for securing handle in any position for valves 4" and small and manual gear operator with hand wheel for valves 5" and larger.

D. Flow control and Flow Balance Valves: For calibrated flow balance valves and automatic flow control valves, see Specification Section 230505, Piping Specialties.

2.5 NATURAL GAS VALVES

A. Valves 3/4" and Smaller: Bronze natural gas cock, Walworth No. 590 (square head), Walworth 591 (flat head), or equivalent.

B. Valves 3" and Smaller: Ball valve shall be cast of ASTM B-584 bronze, Class 250 construction, threaded connections, chrome plated big ball and stem, RDTFE seat and stem packing, blow-out proof stem, UL Listed for natural gas service, Apollo 80-100 Series, or equivalent.

C. Valves 4" and Larger: Lubricated plug valve, cast iron construction, 175 PSIG W.O.G., threaded connection for valves 2" and smaller, Class 125 Flange connections, level handle

operator. Walworth No. 1797F (Flanged), or equivalent.

2.6 MANUAL AIR VENTS AND DRAIN VALVES

A. For manual air vents and drain valves, see Specification Section 230505, Piping Specialties.

2.7 NON-SLAM SILENT CHECK VALVE

A. Check valves for pump discharge and other required non-slam silent operation, shall be center guided, suitable for vertical or horizontal installation position, cast iron in semi-steel body, bronze disc and trim, stainless steel spring, Buna-N seats, Class 125 or 250 construction, as required by the application, wafer or globe flanged pattern for valves 2" through 10" size and flanged pattern for valves 12" and larger. Milwaukee 1400 Series (wafer), or equivalent. Milwaukee 1800 Series (globe), or equivalent.

2.8 TRIPLE DUTY VALVE

A. At the Contractor's option, triple duty valve may be utilized at pump discharge in lieu of non-slam check valve and balance/shut-of valve, see Specifications Section 230505, Piping Specialties.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All valves shall be installed in locations which will allow easy operation and facilitate maintenance.

B. Gate and Globe valves shall be installed with stems horizontal.

END OF SECTION 23 0523

SECTION 23 0549 - HVAC AND ELECTRICAL INSTALLATION COORDINATION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplementary Conditions and General Requirements.

1.2 RELATED DIVISIONS AND SECTIONS

A. Section 23 0500 for Common Work Requirements for HVAC.

B. Section 23 0900 for Facility Management System.

C. Division 1 and Section 230800, Commissioning for HVAC.

D. Division 26 for Electrical.

E. Division 26 for Building Fire Alarm.

1.3 SCOPE

A. It is the intention of this section to summarize the coordination of effort defined in the related sections and divisions of this specification.

B. If there is a conflict between this Section and other Sections and Divisions of this specification, this Section shall be the governing and decisive Section.

C. Make all connections to motors and controls for equipment supplied and/or installed under Division 23 according to Table 1 on the following page.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. No work shall be performed until the reviewed and marked submittal data have been reissued to the Contractor, unless written permission is obtained from the Architect.

TABLE 1

Item or System	Note	Supplied By (3)	Installed By (3)	Powered By	Control Field Wiring By
Equipment Motors		Div. 23	Div. 23	Div. 26	N/A
Motor Control Center Including Starters, Pilot Lights, Heater, Switches, Auxiliary Contacts, and Internal Control Wiring		Div. 26	Div. 26	Div. 26	Div. 23
Stand Alone Motor Starters (outside motor control centers)	(1)	Div. 26	Div. 26	Div. 26	Div. 23
Variable Frequency Drives (VFD's)		Div. 23	Div. 23	Div. 26	Div.23
Fused and Non-Fused Disconnects	(1)	Div.26	Div. 26	Div. 26	N/A
Control Relays & Control Transformers	(1)	Div. 23	Div. 23	Div. 26	Div. 23
Central Plant/Refrigeration Equipment Room Emergency Shutdown & Ventilation		Div. 23	Div. 23	Div. 26	Div. 23
Cooling Tower Vibration Switches		Div. 23	Div. 23	26	N/A
Boilers		Div. 23	Div. 23	Div. 26	Div. 23
Refrigeration Gas Monitor		Div. 23	Div. 23	Div.26	Div. 23
Kitchen Make-up System & Hood Exhaust Fans		Div. 23	Div. 23	Div. 26	Div. 26
Kitchen Exhaust Hoods & Lab Fume Hoods		Div. 23	Div. 23	Div. 26	N/A
Kitchen Hood Fire Protection System		Div. 23	Div. 23	Div. 26	N/A
Kitchen Hood Natural Gas Shut-Off Valve		Div. 23	Div. 23	Div. 26	N/A
Fan Coil Units Including, Return Air Dampers		Div.23	Div. 23	Div. 26	Div. 23
Water Chillers		Div. 23	Div. 23	Div. 26	N/A
Min. Outside Air Units Including Mixing Dampers		Div.23	Div. 23	Div. 26	Div. 23
Rooftop A/C Units Including Mixing Dampers		Div.23	Div. 23	Div. 26	Div.23
HVAC Unit Smoke Detectors		Div. 28	Div. 23	Div. 28	Div. 28
Fire/Smoke Control Dampers & Smoke Dampers		Div.23	Div. 23	Div. 26	Div. 28
Fan Coil Unit Condensate Float Switches		Div.23	Div. 23	N/A	Div. 23
Supply, Return & Exhaust Fan with unit mounted 115 VAC 2-position damper actuators interlock with fan motor/starter		Div. 23	Div. 23	Div. 26	N/A
Non-FMS Control Devices Including Wall Switches, Timers, Thermostats		Div.23	Div. 23	Div. 26	Div. 26
Chemical Treatment Systems		Div.23	Div. 23	Div. 26	N/A

Item or System	Note	Supplied By (3)	Installed By (3)	Powered By	Control Field Wiring By
Cooling Tower Sand Filter Units		Div. 23	Div. 23	Div. 26	N/A
Facility Management System (FMS)	(2)	Div.23	Div. 23	Div. 23	Div. 23
Facility Management System - Light Controls		Div. 26	Div. 26	Div. 26	Div. 26
Fire Alarm System & Interface w/HVAC System		Div. 28	Div. 28	Div. 28	N/A

TABLE NOTES:

1. Unless specified to be supplied with the equipment
2. Division 26 shall provide 120 VAC power to each mechanical space and the central plant as indicated on the drawings. Any additional power, transformers, and distribution shall be provided by the Section or Division indicated.
3. Division 23 indicates the HVAC contractor or their designated representative including equipment suppliers, sub-contractors, etc.

END OF SECTION 23 0549

SECTION 23 0550 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, the Special Conditions, and General Requirements.

1.2 RELATED SECTIONS

A. Section 23 0500 for Common Work Requirements for HVAC.

B. Section 23 3000 for HVAC Air Distribution Systems and Equipment.

C. Section 23 0593 for Testing, Adjusting and Balancing.

D. Section 23 0900 for Facility Management System.

E. Division 22, Section 22 0550 for plumbing variable frequency drives.

1.3 GENERAL

A. Variable frequency drives shall be coordinated with the equipment being furnished and the wiring coordinated with the Division 26 contractor.

B. Do not connect power factor correction devices in the electrical circuit serving any variable frequency drive or the motor downstream of the drive.

C. All associated equipment motors shall be inverter duty in compliance with standard NEMA MG 1 Part 31 to ensure the compatibility between the VFD and motor.

D. Manufacturer's Qualifications: Firms regularly engaged in manufacture of variable speed ac motor drives of types and ratings required, whose products have been in satisfactory use in similar service for not less than five years. All Division 23, HVAC and Division 22, Plumbing variable frequency drives shall be of one manufacturer/model series and be provided by the exclusive local representative for sole source responsibility of all aspects of sales, startup, service, training and warranty.

E. Variable frequency drives shall be manufactured by Asea Brown Boveri (ABB), Series ACH 550, Magnetic, Reliance, or equivalent.

F. Substitutions must have Consulting (Mechanical/Electrical) Engineer written approval two (2) weeks prior to date of bid. Written approval does not relieve supplier of specification requirements. All clarifications and/or exceptions to this specification shall be submitted in writing to the Consulting Engineer at that time.

1.4 SUBMITTALS

A. Refer to Sections 23 0500 for additional requirements.

B. Product Data: Submit manufacturer's data including catalog information, performance data efficiency, harmonic distortion, RFI/EMI (Radio Frequency Interference/ Electromagnetic Interference) specifications, installation instructions and general recommendations for each type or size of motor.

C. The VFD manufacturer shall provide calculations as part of the shop drawing submittal specific to this installation, showing total harmonic voltage distortion is less than 5%. Input line filters shall be sized and provided as required by manufacturer to ensure compliance with IEEE Standard 519-1992, "Guide for Harmonic Control and Reactive Compensation for Static Power Converters."

D. The manufacturer furnishing the variable frequency drives shall be responsible for noise created by VFD's and/or motors. The manufacturer shall submit his noise test data based on the following: Sound power level at any speed output of the VFD, measure 3 ft. from the motor, shall not exceed 1.2 times the sound power level of the motor running in bypass mode with 60 Hz incoming line power. Measurements shall be recorded at 10 (minimum) different operating speeds.

E. Shop Drawings: Submit dimensioned drawings of cabinet and front panel layout, showing accurately scaled switches, their layouts and proximity to associated equipment. Furnish control schematic connection diagram showing all field connections.

1.5 SCOPE

A. Furnish and install pulse width modulating (pwm) output wave HVAC Variable Frequency Drives (VFD) and control wiring between the VFD control system as specified in Section 23 0550.

B. The Variable Frequency AC Motor Drive shall be designed to convert the 460 volt with a tolerated voltage window ± 30%, 3 phase, 60 Hz input power to 0 to 460 volt, 3 phase, 0-60 Hz variable frequency output power. The output frequency and voltage of the drive shall be variable such that a constant volts/Hz ratio is maintained throughout the operating range. The volts/Hz ratio shall be adjustable.

C. The drive shall be capable of operating any standard "off-the-shelf," NEMA B Design, squirrel cage induction motor with a 1.15 SF. The full load amp rating of the drive, adjusted as required for jobsite elevation and ambient conditions, shall be not less than 5% greater than the FLA rating of the motor or VFD must be oversized.

D. For maintenance purposes, the drive shall be capable of starting, stopping, and running with stable operation with the motor completely disconnected (no load).

E. Equipment will be designed and manufactured in accordance with applicable current NEMA, IEEE Standard 519-1992, (IEEE Guide for Harmonic Content and Control), UL 508, ISC 6 Enclosures for Industrial Controls and Systems, and IEC 801-2, 801-4, 255-4 recommendations and be designed for installation per NEC. Equipment will have UL, CUL, or ETL Listing or CSA listing as approved and accepted by the state and local code authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES

A. Each VFD shall be of the pulse width modulating design and shall consist of:

1. A full-wave diode bridge rectifier to convert incoming fixed voltage/frequency to a controlled DC voltage.

2. A DC bus filter with a power factor of .95 or better over the entire speed range.

3. The drive efficiency shall be 97% or better at full speed and full load. Efficiency shall not be less than 80% at 50% speed and load.

4. An inverter section to change the controlled DC voltage to a PWM adjustable voltage/frequency output for complete motor speed control. The inverter output will be generated by power transistors which will be controlled by six identical base driver circuits.

B. The VFD shall include the following:

1. The unit enclosure shall be NEMA Type 1, metal cabinet with front hinged access doors allowing access to all internal electric connections. Any VFD's mounted inside an equipment room with unducted return air and/or mounted in AHU (air handling unit) shall be furnished with NEMA type enclosure required by the local Construction Codes. All VFD's shall be UL Listed as plenum rated.

2. Electronic switching components shall be insulated gate/bipolar transistors, (IGBT).

3. An externally operated, door interlocked, fused disconnect switch or circuit breaker shall be provided. The base VFD shall be UL Listed with a short circuit interrupting rating of 100,000 symmetrical amps minimum without the need for input fuses. The DC Buss output shall be fused separately or electronically protected, with a indicating pilot light.

4. An internal 115V AC control power circuit with transformer and protective fuses shall be included or 250 mA of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others.

5. Provide solid state relay interface for remote start/stop in both VFD and bypass mode independent of safety circuits.

6. Low frequency/low voltage start with linear adjustable ramp up to pre-selected speed.

7. Controlled acceleration and deceleration, separately adjustable, shall be provided from 2 to 180 seconds with torque limit override acceleration protection, and regeneration protection.

8. Critical Frequency lock out to skip over frequencies that may cause unstable operation in equipment being controlled. Provide at least three separate lockout settings.

9. The VFD 'run permissive circuit' will provide a normally open contact whenever a run command is provided (local or remote start command in VFD or bypass mode). The VFD system (VFD or bypass) shall not operate the motor until it receives a system ready

command/contact closure.

10. Furnish line reactors/inductors with minimum 5% impedance designed to provide proper protection of harmonics and transients for the drive input power line. This is a minimum requirement and the manufacturer shall furnish higher rated line reactors or isolation transformers as may be necessary to maintain specified maximum total harmonic voltage distortion. Line reactors/transformers shall be factory mounted and wired within VFD enclosure. The 5% impedance reactors may be from dual (positive and negative DC bus) reactors, or 5% impedance AC line reactors. VFD's with only one 5% DC reactor shall add AC line reactors.

11. EMI / RFI (Radio Frequency Interference/Electromagnetic Interference) filters. All VFD's shall include EMI/RFI filters onboard to allow the VFD assembly to be CE marked and meet product Standard EN 61800-3 for the First Environment restricted level.

12. All components must be accessible from the cabinet door for service. The control shall be microprocessor based and the control card shall be the same part number and fully interchangeable for all ratings and voltages of VFDs.

13. Drive must be designed for against the wall and/or floor mounted arrangements, as required by the project installation requirements.

14. The drive shall be software programmed to provide automatic restart after a power outage or trip from overcurrent, over voltage, under voltage or over temperature. A delay shall occur before restart to allow motor to stop completely. The drive shall shut down and shall require manual restart if the automatic reset/restart function is not successful within 3-5 attempts within a short time period.

15. The VFD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to setpoint without safety tripping or component damage (flying start). The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fireman's control station, the VFD shall override all other inputs (analog/digital, serial communication, and all keypad commands) and force the motor to run at the adjustable, preset speed.

16. The VFD shall be equipped with an automatic extended power loss ride-through circuit which will utilize the inertia of the load to keep the drive powered. Minimum power loss ride-through shall be one-cycle, based on full load and no inertia. Removing power from the motor is not an acceptable method of increasing power loss ride-through.

17. Furnish terminal strip for external interlocks, isolated from the line and ground.

18. Furnish prewired keypad with 3-position HAND-OFF-AUTO switches/buttons and manual speed control that will incorporate "bumpless transfer" of speed reference when switching between "HAND" and "AUTO" modes. When in "HAND," the VFD will be started, and the speed will be controlled from the manual speed control. When in "OFF," the VFD will be stopped. When in "AUTO," the VFD will start via an external contact closure, and its speed will be controlled via an external speed reference.

19. The drive shall employ three (3) current limit circuits to provide trip-free operation:

    a. The Slow Current Regulation limit circuit shall be adjustable to 125%

(minimum) of the VFD's variable torque current rating. This adjustment shall be made via the keypad, and shall be displayed in actual amps, and not as percent of full load.

b. The Rapid Current Regulation limit shall be adjustable to 170% (minimum) of the VFD's variable torque current rating.

c. The Current Switch-Off limit shall be fixed at 255% (minimum, instantaneous) of the VFD's variable torque current rating.

20. The overload rating of the drive shall be 110% of it's variable torque current rating for one (1) minute every 10 minutes, and 140% of it's "H" torque current rating for two (2) seconds every 15 seconds.

21. The VFD shall have door interlocked thermal magnetic circuit breaker which will disconnect all input power from drive and all internally mounted options when bypass is required. The disconnect handle shall be thru-the-door type, and be padlockable in the OFF position.

22. The VFD shall have input line fuses mounted in drive enclosure.

23. The VFD shall be optimized for a 3 kHz carrier frequency to reduce motor noise. The carrier frequency shall be adjustable by the start-up engineer. VFD shall reduce the carrier frequency based on actual VFD temperature that allows the highest carrier frequency without derating the VFD.

C. The VFD shall have a programmable digital operators keypad located in the front door of the drive enclosure which shall include the following features and requirements.

1. All VFDs shall have the same customer interface, including digital display, keypad and customer connections; regardless of horsepower rating. The keypad is to be used for local control (START/STOP, FORWARD/REVERSE, and speed adjust), for setting all parameters, and for stepping through the displays and menus.

2. A VFD mounted transfer switch motor selection option shall be provided to allow the operator to manually transfer between two motors. Interlocking shall be provided to prevent switching of the drive while operating. Use of external motor starters shall not be allowed.

3. The VFD shall give the user the option of either 1) displaying a fault, or 2) running at a programmable preset speed or last speed known if the input reference (4-20 mA or 2-10V) is lost; as selected by the user.

4. The VFD’s shall utilize plain English digital display (code numbers are not acceptable). The digital display shall be a 40-character (2 line X 20 characters/line) LCD display. The LCD shall be backlit to provide easy viewing in any light condition. The contrast should be adjustable to optimize viewing at any angle. All set-up parameters, indications, faults, warnings and other information must be displayed in words to allow the user to understand what is being displayed without the use of a manual or cross-reference table.

5. There shall be a built-in time clock used to date and time stamp faults and record operating parameters at the time of fault. The clock shall also be programmable to control start/stop functions, constant speeds and four (4) separate, independent timer functions that have both weekday and weekend settings.

6. The VFD's shall utilize pre-programmed application macro's specifically designed to facilitate start-up. The digital keypad shall be removable, capable of remote mounting and uploading/downloading parameters and HVAC specific Application Macros that shall provide one (1) command to reprogram all parameters and customer interfaces for a particular application to reduce programming time and initial start-up of multiple VFDs.

7. The VFD shall have a manual speed control integral to the keypad.

8. Analog meter - output percent of maximum speed.

9. VFD shall have RS-485 port. The standard protocols shall be Modbus RTU, Johnson Controls N2 bus, Siemens Building Technologies FLN and BACnet available. No additional hardware, firmware, gateways, etc., shall be required for these standard protocols. Optional protocols for Lon Works, Profibus, Ethernet, and DeviceNet shall be available, and have the protocol in each VFD. The use of third party gateways and multiplexers is not acceptable.

10. All protocols shall be "certified" by the governing authority, non-certified protocols are not allowed. If additional gateway, hardware, etc., is required to obtain the BACnet, Modbus, etc., interfaces, the VFD manufacturer shall supply one (1) gateway, hardware device, etc., per VFD. Multiple VFD's sharing one (1) gateway, hardware, etc., shall not be acceptable.

11. BACnet connection shall be an RS485, MSTP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs (BACnet Interoperability Building Blocks) defined by the BACnet standard profile for a B-ASC.

12. All wires to be individually numbered at both ends for ease of troubleshooting.

13. The following operation information displays shall be standard on the VFD digital display. The display shall be complete English words (alpha-numeric codes are not acceptable):

    a. Output Frequency

    b. Motor Current

    c. Calculated Motor Torque

    d. Calculated Motor Power

    e. DC Bus Voltage

    f. Output Voltage

    g. Heatsink Temperature

    h. Analog Input Values

    i. Keypad Reference Values

    j. Elapsed Time Meter

    k. kWh Meter

D. The drive shall have the following field adjustments:

1. Five (5) programmable critical frequency lockout ranges to prevent the VFD from

continuously operating an unstable speed.

2. PID setpoint controller shall be standard in the drive, allowing a pressure or flow signal to be connected to the VFD, using the microprocessor in the VFD for the closed loop control. There shall be an independent, second PID loop that can be utilized to maintain setpoint of an independent process (i.e. valves, dampers, cooling tower bypass valve control, chilled water valve control, etc.

3. Two (2) programmable analog inputs shall accept a current or voltage signal for speed reference, or for reference and actual signals for PI controller. Analog inputs shall include a filter; programmable from 0.01 to 10 seconds to remove any oscillation in the input signal. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0 - 20 mA and 0 - 10 volts. Additionally, the reference must be able to be scaled so that maximum reference can represent a frequency less than 60 Hz, without lowering the drive maximum frequency below 60 Hz.

4. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices.

5. Two (2) programmable analog outputs proportional to frequency, motor speed, output voltage, output current, motor torque, motor power, DC bus voltage, or active reference.

6. Three (3) programmable digital relay outputs. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 amps at 250 VAC; maximum voltage 30 VDC and 250 VAC; continuous current rating 2 amps RMS. Outputs must be true form "C" type contacts; open collector outputs are not acceptable.

7. Two (2) independently adjustable accel and decel ramps. These ramp times shall be adjustable from 1 to 1800 seconds.

8. Two (2) independently adjustable accel and decel ramps. These ramp times shall be adjustable from 1 to 1800 seconds.

9. The VFD shall ramp or coast to a STOP, as selected by the user.

E. Speed Command Input shall be via:

1. Keypad or manual speed control as selected by user.

2. Two (2) analog inputs, each capable of accepting a 0-20mA, 0-10V, 2-10V signal. Input shall be isolated from ground, and programmable via the keypad for different uses.

3. Analog inputs shall have a programmable filter to remove any oscillation of the reference signal. The filter shall be adjustable from 0.01 to 10 seconds. The analog input should be able to be inverted, so that minimum reference corresponds to maximum speed, and maximum reference corresponds to minimum speed. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0-20mA and 0-10 volts.

4. Floating point input shall accept a three-wire input from a Dwyer Photohelic, or equivalent type instrument.

2.2 USER SELECTABLE AUTOMATIC/MANUAL BY-PASS
(Operation of motor at full voltage at 60 Hz fixed speed).

A. Input line fused disconnect (service switch) and/or fast acting fuses exclusive to the VFD will allow the VFD to be disconnected from the line prior to clearing ups tream branch circuit protection to maintain bypass capability. Door interlocked, pad-lockable circuit breaker will disconnect all input power from the drive and all internally mounted options, together with fully rated magnetic motor starters mechanically interlocked shall be used to transfer motor to line power. Transfer must occur in orderly fashion causing no component damage to either drive or motor. Manual bypass circuitry must be integral part of drive cabinet. Separate bypass or starter enclosure is not acceptable. The VFD shall be UL Listed by the drive manufacturer and UL508 label complete bypass assembly.

1. An output contactor, bypass contactor and VFD only disconnect/service switch and/or fuses will be provided. Overload protection shall be provided in both drive and bypass modes.

2. Provide user selectable manual or automatic bypass.

3. Bypass designs that incorporate fuses common to both the VFD and the bypass will not be accepted. Three contactor bypass schemes are not acceptable, as a VFD input contactor is not a NEC recognized, lockable, physical disconnect and is an unacceptable means of safely disconnecting power to VFD.

4. The drive / bypass shall provide single-phase motor protection and under-voltage protection of bypass, contactor coils, etc., shall be in both the VFD and bypass modes.

5. The following operators shall be provided:

   a. Bypass HAND-OFF-AUTO

   b. Drive mode selector

   c. Bypass mode selector

   d. Bypass fault reset

6. Dedicated digital input that will transfer motor from VFD mode to bypass mode upon dry contact closure for fireman's override. Two modes of operation: One mode forces the motor to bypass operation. The second mode as above also defeats all safeties and inputs (run until destruction).

A. Furnish auxiliary contacts to monitor drive status with FMS. A drive failure of any kind shall produce alarm signal and FMS.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The drive shall be installed in strict accordance with manufacturer instructions. A minimum of 42" clearance shall be maintained in front of drives.

3.2 EQUIPMENT PROTECTION

A. Whenever possible drive shall be mounted within sight of motor that is controlled by drive. In the event that drive is not mounted within sight of motor, a disconnect will be installed (under Division 26) within sight of motor. If a disconnect is installed between motor and drive the drive supplier shall provide a 6" x 6" red engraved warning sign to be mounted at the disconnect which shall read as follows:

"WARNING: TO AVOID DAMAGE TO FREQUENCY DRIVE DO NOT PULL DISCONNECT, EXCEPT IN AN EMERGENCY, UNTIL FREQUENCY DRIVE IS SHUTDOWN."

B. Drive shall include a coordinated AC transient protection system consisting of MOV's (Metal Oxide Varistors: phase-to-phase and phase-to-ground), a capacitor clamp, and 5% impedance reactors designed to protect itself against all normal transients and surges in the incoming power line, any grounding or disconnecting of its output power, and any interruption or run away of the incoming speed reference signal. Protection is defined as a normal shutdown with no component damage.

C. In general the drive shall contain the following protective circuits. In the case of a protective trip, the drive shall STOP, and announce the fault condition in complete words (alpha-numeric codes are not acceptable).

1. Overcurrent trip 200% of the VFD's variable torque current rating.

2. Overvoltage trip 130% of the VFD's rated voltage.

3. Undervoltage trip 60% of the VFD's rated voltage.

4. Ground Fault.

5. Adaptable Electronic Motor Overload (I^2t). The electronic motor overload protection shall protect the motor based on speed, load curve, and external fan parameter. Circuits which protect the motor only at full speed are unacceptable.

3.3 OPERATING CONDITIONS

A. +/- 10% line voltage variations.

B. 5% incoming line frequency variations.

C. Maximum output frequency variations shall be +/- .25%.

D. FLA to meet or exceed UL/NEC table 430-150 of the minimum motor horsepower specified on the equipment schedule on the drawings.

E. Ambient temperature.

1. 0 to 50OC - NEMA 1 and 12 indoor enclosures: 1 thru 50 HP, 480 & 230 volt shall be capable of continuous operation as per VFD manufacturers documented/submittal data or VFD musts be oversized.

2. 0 to 40OC - NEMA 1 and 12 indoor enclosures: 60 thru 550 HP, 480 & 230 volt, shall be capable of continuous operation; From 49 to 50 Deg. C (104 to 122 Deg. F.), VFD current de-rate as per VFD manufacturers documented/submittal data or VFD must be oversized.

3. 0 to 50OC - NEMA 3R outdoor enclosures inclusive of all HP and voltages shall be capable of continuous operation as per VFD manufacturers documented/submittal data or VFD must be oversized.

F. Altitude.

1. 0 to 3300 feet above sea level without deration.

2. Derate per manufacturer's recommendation for project elevations above 3300 feet.

G. 90% Maximum humidity (non-condensing).

3.4 TESTING AND DOCUMENTATION

A. Manufacturer to conduct standard factory tests to assure compliance with specification requirements.

B. Manufacturer's local Designated Service Station's startup technician shall provide field startup and commission of all VFDs and shall demonstrate trouble free, stable operation for conditions of starting, full load, three quarter load, half load, quarter load, no load and intermediate loads. The local Designated Service Station shall have factory trained and certified applications engineer/service personnel to provide service, training and warranty onsite 24/365 (24 hours / 365 days per year) and a toll-free support line. Provide four (4) hours onsite training of programming and operation.

C. Field tests shall include 100 hours of operation under load to demonstrate adequacy of equipment under thermal and voltage stresses, and that harmonic and other interferences do not adversely affect the electrical instrumentation and communications systems.

D. Manufacturers technically qualified and factory trained representative to make final written documents of installation, inspection and test run.

E. Field testing to include demonstration of automatic restart under operation of the following existing controls:

1. Fire Alarm.

2. Nitestat.

3. OFF/AUTO Switch.

4. Clock Control.

5. FMS START/STOP in both VFD and BYPASS MODE.

F. Switching from bypass to VFD operation both manually and automatically which shall be user selectable.

G. Complete records of test procedure and results to be made available at no additional cost to purchaser's representative.

H. Equipment shall carry a two (2) year guarantee as to workmanship, material, and satisfactory functioning from date of startup or maximum of 30 months from date of shipment from factory.

I. Furnish complete sets of their drawings showing control schematics, transistor schematics, wiring, outline dimensions, mounting details and equipment weight.

J. Operating & Maintenance Data and Spare Parts List: Furnish copies of all instruction books, spare parts lists and special bulletins covering on-site installation and operation in accordance with Section 23 0500.

END OF SECTION 23 0550

SECTION 23 0593 - TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Testing and balancing of the mechanical systems shall be under the direction and coordination of the HVAC and Controls Performance Assurance Contractor (PAC) directly contracted by the Owner. THE PAC SHALL PROVIDE THE OWNER'S TEST AND BALANCE (TAB) SERVICES and shall be responsible for coordination, supervision, execution, furnishing the data required by the test procedures, and report preparation for the testing, adjusting, and balancing requirements outlined in this Section.

B. TAB will be provided by the Owner's PAC and paid for by the Owner. This Section serves to clarify the responsibilities of the Contractor and describes the procedures of the Owner's PAC.

C. During the testing, adjusting, and balancing work, the Owner's PAC may identify issues or recommended corrective measures. These will be compiled in the Installation Issues Log maintained by the PAC and RFIs will be created by the PAC as appropriate. The Construction Stage Deficiency Log will be promulgated to responsible parties via the Owner's Representative and the Architect. Implementation of corrections shall be performed by the Contractor at no additional charge. If the Contractor believes recommended corrections are beyond the scope of work specified in the contract, it shall be the Contractor's responsibility to request and receive written change order authorization through the Owner's established process prior to undertaking those recommended corrections.

D. The Contractor shall provide services of a qualified manufacturer's representative of the Direct Digital Control System and qualified representatives of the mechanical and electrical subcontractors as required for the TAB work and Contractor shall include Contractor's cost for the Contractor's testing, adjusting, and balancing requirements in his contract price. Services of the TAB Agency shall be provided by the Owner and are not part of the contract price.

E. Mechanical system installation, start-up, initial testing, the preparation of Operation and Maintenance Manuals, and operator training are the responsibility of the Contractor. The testing, adjusting, and balancing requirements in this Section do not relieve the Contractor from the obligations to complete all portions of the work in a satisfactory and fully operational manner.

F. The Owner's PAC shall include the following in its Scope of Work:

1. Perform Testing and Balancing of the systems. Contractor shall provide full-time services of electrical and control subcontractors for this testing and balancing work.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. The general provisions of the Contract, including General Conditions, Supplementary General Conditions (if any), and General Requirements apply to the work specified in this Section.

Section 23 0500	General Mechanical Requirements
Section 23 0500	Common Work Requirements for HVAC
Section 23 2113	Heating Water System & Equipment
Section 23 2123	Pumps
Section 23 2313	Refrigerant Piping System & Equipment
Section 23 3000	Air Tempering System and Equipment
Section 23 3423	HVAC Power Ventilators
Section 23 3713	Diffusers, Registers & Grilles
Section 23 3813	Kitchen Exhaust and Makeup Air Systems
Section 23 5216	Condensing Boilers
Section 23 7313	Modular Multizone indoor Central-Station Air Handling Units
Section 23 7413	Outdoor Central Station Air Handling Units
Section 23 0810	Performance Assurance for HVAC

1.3 REFERENCES

A. AABC – National Standards for Total System Balance

B. ASHRAE 111 – Practices for Measurement, Testing, Adjusting, and Balancing of Environmental Systems

C. NEBB – Procedural Standards for Measurement, Testing, Adjusting, and Balancing of Environmental Systems

D. SMACNA – HVAC Systems Testing, Adjusting, and Balancing

1.4 SUBMITTALS BY OWNER'S PAC

A. Field Reports indicating deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

B. Report forms or outlines indicating adjusting, balancing, and equipment data required. Submit prior to commencing work.

C. Test Reports including data on forms containing information indicated in Schedules.

D. Draft copies of TAB Report for review prior to Substantial Completion of Project.

E. Copies of final TAB Report for inclusion in the Final HVAC and Controls Performance Assurance Report

F. Provide submittals and reports to PAC for transmittal to Owner's Representative and Design Professional.

G. Provide reports in letter size, 3-ring binder manual format complete with index page, indexing tabs, and with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat/temperature sensor locations.

1.5 QUALITY ASSURANCE

A. Perform total system balance in accordance with NEBB Procedural Standards.

1.6 SEQUENCING

A. Sequence TAB work in conjunction with work by the Contractor. TAB work and milestones shall be incorporated in the Contractor's Project Schedule.

B. Sequence TAB work to commence after completion of systems. TAB work shall be completed as a prerequisite for Substantial Completion of the Project.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 AGENCIES

A. The independent Owner's PAC will be responsible for coordination, supervision, execution, and report preparation for the testing, adjusting, and balancing requirements of this Section.

3.2 SYSTEM READINESS

A. Contractor shall verify that systems are installed, complete and operable before the commencement of TAB work. The contractor shall insure the following conditions:

1. Systems are started and operating in a safe and normal condition.

2. Direct Digital Control System and temperature controls are installed complete and operable including verification of proper end device operation and installation of required software and programming.

3. Proper thermal overload protection is in place for electrical equipment

4. Final filters are new and in place.

5. Coil fins are clean and combed if needed

6. Duct systems are clean of debris.

7. Fans are rotating correctly

8. Motors and bearings are properly lubricated.

9. Any excessive vibration has been corrected.

10. Fire/Smoke and volume dampers are in place, open, and operating properly.

11. All ductwork connections are complete, access doors are closed, and duct end caps are in place.

12. Air outlets are installed and connected.

13. Duct system leakage is minimized per the Specifications.

14. Water systems have been flushed, refilled, and vented.

15. Strainers or filters are in place and clean.

16. Control valves, check valves, and flow meters are installed and operating properly.

17. All manual valves, balancing devices, and control valves are open.

18. Pump rotation is correct and water is flowing.

19. System make-up water pressure is properly adjusted.

B. Construction Checklist forms to verify the readiness of systems for TAB work are provided following the end of this Section. The project-specific Construction Checklists developed by the Owner's PAC shall be used for the project. The Contractor shall have personnel with direct knowledge complete the individual checklists to verify that systems are installed, complete and operable prior to the commencement of TAB work. ***These checklists do not replace any manufacturer-recommended procedures***.

C. Prior to commencement of TAB work, the Contractor shall submit a written request to the Owner, including completed Construction Checklists forms for mechanical inspection of the project. This inspection shall be conducted by a duly appointed representative of the Mechanical Engineer's office, the Mechanical Contractor's Superintendent, and representatives of the Owner's PAC. The inspection shall establish to the satisfaction of all parties that the systems are ready for testing and balancing.

If the Owner's PAC finds that systems are not ready for TAB services Contractor will be subject to charges for the Owner's PAC's lost time and expenses.

3.3 PREPARATION

A. The Owner's PAC shall provide necessary calibrated instruments required for testing, adjusting, and balancing operations. The Owner's PAC shall make instruments available to Architect/Engineer to facilitate spot checks during testing.

B. Additional balancing devices, if required, shall be furnished and installed by Contractor.

3.4 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 10 percent of design conditions for supply systems and within plus or minus 10 percent of design conditions for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus or minus 10 percent of design conditions to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design conditions.

C. If tested air quantities are not within the required limits, the Contractor must replace fan pulleys, sheaves, belts, or add balancing dampers, etc. as required to meet the Specifications. If acceptable to Contractor, TAB Agency may install replacement pulleys, sheaves, or belts as required to meet the Specifications. Installation of pulleys, sheaves, or belts by TAB Agency shall have no effect on Contractor's warranty.

D. Water: Adjust to within plus or minus 10 percent of design conditions.

3.5 ADJUSTING BY OWNER'S PAC

A. Ensure recorded data represents actual measured or observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices to allow settings to be restored. Set and lock memory stops.

C. After adjustments, take measurement to verify balance has not been disrupted or that such disruption has been rectified.

D. Leave systems in proper working order, replace belt guards, close access doors, close doors to electrical switch boxes, restore thermostats to specified settings, and restore Direct Digital Control System to normal operation.

E. At Final Inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

3.6 PROCEDURE BY OWNER'S PAC

A. Air Handling and Distribution Systems

1. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

2. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

3. The total air volume handled by the system shall be determined by means of a Pitot tube and draft gauge. The total air delivered by each duct shall be measured by Pitot tube traverses.

4. The average velocity in the duct shall be determined by velocity readings which are taken in the center of equally divided areas in the cross section of the duct. The number of areas

in which velocity readings are to be taken is determined by the size of the duct, based on a maximum size of equally divided areas of 8 inches.

5. Measure air quantities at air inlets and outlets. The volume dampers, pressure controllers, outlets and other devices shall be adjusted so the air volumes will be as shown on the drawings.

6. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

7. Use volume control devices to regulate air quantities only to the extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

8. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

9. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

10. Measure air static pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

11. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

12. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

13. Where modulating dampers are provided, take measurements and balance at extreme conditions.

14. Measure building static pressure and adjust supply, return, and exhaust systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

15. On completion of the test the Owner's PAC shall prepare a typewritten report showing the tested values for inclusion in the Final HVAC and Controls Performance Assurance Report. This report shall include all flows, temperatures, temperature drops, and motors for the plumbing and mechanical systems. The CFM of each supply outlet with corresponding room number shall be included. This report shall include the fan RPM, nameplate data, the voltage and amperage readings of the fan motors, and the fan suction and discharge static pressure.

B. Water Systems

1. Verify systems have been flushed clean, strainers and filters are in place and clean, and that the system has been refilled and vented.

2. Verify that Contractor has installed all temperature and pressure test plugs as required to obtain a thorough flow test.

3. Balance all water flows using pump curve data. Balance all chilled water coils, hot water coils, heat exchangers, cooling towers, boilers, and chillers to specified flow rates.

4. Provide air and water entering and leaving conditions on all equipment.

5. Record pump flow rates, pressures, running amperage, and full load amperage at design flow and shut off conditions.

3.7 SCHEDULES BY OWNER'S PAC

A. Equipment Requiring Testing, Adjusting, and Balancing:

1. Air Handling Units

2. Fans

3. Air Filters

4. Air Inlets and Outlets

5. Heating System Pumps and Water Flows

6. Direct Digital Control System

B. The Owner's PAC's report shall contain all test, adjustment, and balance data and information on any discrepancies from the specifications or design conditions. The following should be included as a minimum:

1. Title Page
    a. Name of Owner's PAC
    b. Address of Owner's PAC
    c. Telephone Number(s) of Owner's PAC
    d. Project Name
    e. Project Location
    f. Project Architect
    g. Project Engineer
    h. Project Contractor
    i. Project Altitude
    j. Report Data

2. Summary Comments
    a. Final Performance versus Design

b. Notable characteristics of systems

c. Identify any instances where the actual control sequence of operation varies from the designed and submitted sequences.

d. Summary of outdoor and exhaust air flows to indicate amount of building pressurization

e. Nomenclature used throughout report

f. Test conditions

3. Instrument List

a. Instrument Used

b. Manufacturer

c. Model Number

d. Serial Number

e. Calibration Date

4. Electric Motors

a. Manufacturer

b. Model/Frame

c. HP/BHP

d. Phase, voltage, amperage, nameplate, actual, no load

e. RPM

f. Service factor

g. Starter size, rating, heater elements

h. Sheave make, size, bore (as installed and any replacement)

5. V-Belt Drive

a. Identification/Location

b. Required driven RPM

c. Driven sheave diameter and RPM (as installed and any replacement)

d. Belt size and quantity

e. Motor sheave diameter and RPM (as installed and any replacement)

6. Air Moving Equipment

a. Location

b. Manufacturer

c. Model Number

d. Serial Number

e. Supply air flow - specified and actual

f. Return air flow - specified and actual
g. Outside air flow - specified and actual
h. Total external static pressure – specified and actual
i. Inlet pressure
j. Discharge pressure
k. Sheave - make/size/bore (as installed and any replacement)
l. Belts - make/size/quantity
m. Fan RPM

7. Return Air/Outside Air Data
   a. Identification/location
   b. Design air flow
   c. Actual air flow
   d. Design return air flow
   e. Actual return air flow
   f. Design outside air flow
   g. Actual outside air flow
   h. Return air temperature
   i. Outside air temperature

8. Exhaust Fan Data
   a. Location
   b. Manufacturer
   c. Model Number
   d. Serial Number
   e. Air flow - specified and actual
   f. Total external static pressure – specified and actual
   g. Inlet pressure
   h. Discharge pressure
   i. Sheave - make/size/bore (as installed and any replacement)
   j. Belts - make/size/quantity
   k. Fan RPM

9. Duct Traverse
   a. System zone/branch
   b. Duct size
   c. Area

d. Design velocity

e. Design air flow

f. Test velocity

g. Test air flow

h. Duct static pressure

i. Air Temperature

j. Air correction factor

10. Water Systems

a. Location

b. Pump Manufacturer

c. Pump Model Number

d. Pump Serial Number

e. Water flow - specified and actual

f. Total pressure – specified and actual

g. Suction pressure

h. Discharge pressure

i. Full load amperage at design flow and shut off conditions

11. Vibration Test (by Owner's PAC if required by Owner)

a. Location of points
   - Fan/pump bearing drive end
   - Fan/pump bearing opposite end
   - Motor bearing drive end
   - Motor bearing center (if applicable)
   - Motor bearing opposite end
   - Casing bottom or top
   - Casing side
   - Duct after flexible connection (discharge)
   - Duct after flexible connection (suction)

b. Test readings
   - Horizontal - velocity and displacement
   - Vertical - velocity and displacement
   - Axial - velocity and displacement

c. Normally acceptable readings, velocity and acceleration

d. Unusual conditions at time of test

e. Vibration source if non-complying

12. Life Safety Systems

    a. The Contractor shall be required to demonstrate satisfactory operation of Life Safety Controls and Smoke Damper operation to the Test and Balance Agency unless the appropriate Authority Having Jurisdiction requires separate verification by the local Fire Marshal.

END OF SECTION 23 0593

SPACE RESERVED FOR
PROJECT TITLE (OPTION 2)
WILL BE INSERTED IN FINAL
PDF

SECTION 23 0700 - MECHANICAL SYSTEMS INSULATION

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplementary Conditions and General Requirements.

1.2 RELATED SECTIONS

A. Section 23 0500 for Common Work Requirements for HVAC.

B. Section 23 0504 for Pipe and Pipe Fittings.

C. Section 23 3000 for Air Tempering System and Equipment.

1.3 SCOPE

A. Field insulation of piping: see drawings and Part 3 of this spec.

B. Field insulation of ductwork: see drawings, Table 230700-1, and Part 3 of this spec.

C. Field insulation of equipment supplied and/or installed under Division 23: see drawings and Part 3 of this spec.

D. Factory-insulated equipment and materials are described on the equipment schedule, on the drawings, and in other sections of this specification.

1.4 SUBMITTALS

A. Submit products to be used including insulation, jackets, miscellaneous products, and products for special applications. Review each application and advise if any product is either not suitable for, or not recommended for the application.

B. Verify that each submitted product meets all requirements for that product as specified herein. Include literature that clearly shows products meet all aspects of the spec. Include a cover sheet or letter with the following statement:

"Each product submitted here meets all specified requirements for that product except as follows:" followed by a list of any discrepancies.

C. Submit schedules showing the type of product and thickness for each application. Indicate products to be used on valves and fittings. Indicate where vapor barriers will be provided and what jackets will be used.

D. D-5, D-6 & D-7 insulation: If one of these insulations is specified, submit documentation indicating that the submitted materials are approved for the intended service.

E. Submit a description of the application techniques to be used.

1.5 QUALITY ASSURANCE

A. Comply with the latest edition of the National Commercial & Industrial Insulation Standards, as published by the Midwest Insulation Contractors Association.

B. Part 3 and Table 23 0700-1 give the system temperatures for various applications. Supplier shall review these temperatures and confirm the suitability of all components for the specified applications.

C. Test piping and ductwork in accordance with applicable specification sections before insulation is applied.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials must be 100% asbestos-free.

B. All materials must be GreenGuard Certified, GreenGuard Certified for Children and Schools.

C. Smoke and Fire Ratings: All materials shall have a composite fire and smoke hazard rating not exceeding flame spread 25, fuel contribution 50, smoke developed 50, when tested as assemblies per ASTM Standard E-84 or NFPA 255.

D. Thermal conductivities: Per ASTM C518. Do not exceed the conductivities indicated. Units listed herein for conductivity are Btuh-in/SF-F. Resistance shall not be less than the values specified herein. Units for resistance are SF-F/Btuh.

E. Noise Reduction Coefficients: Per ASTM C423 based on Type A mounting. NRC shall not be less than as specified.

F. Jackets: Maximum 0.02 perm water vapor transmission per ASTM E96 Procedure A.

1. ASJ: All service jacket per ASTM C1136 Type I, paintable white kraft paper outer surface reinforced with glass fiber yarn and bonded to aluminum foil, with self-sealing longitudinal lap and butt strips, breach puncture min. 50 oz-in/in tear per ASTM D781, tensile strength min. 30 lb/in per ASTM D828.

2. FSK: Foil skim kraft per ASTM C1136 Type II.

G. Fiberglass insulation: Inorganic fibers bonded with thermosetting resin.

H. Approved Manufacturers: Owens Corning, Johns Manville, Knauf, Certain-Teed, Kflex, Armacell, Unifrax -Insulfrax, Industrial Insulation Group, Pittsburgh Corning. Where the term

OAE is used herein, this refers to these manufacturers only. No other manufacturers are approved for this project.

2.2 PIPE INSULATION

A. General

1. Valves, Fittings, and Accessories: Use the same insulation materials and thickness as the pipe insulation, except as noted.

B. Type P-1, Fiberglass Pipe Insulation: Factory assembled insulation and ASJ. Pre-formed fiberglass per ASTM C547 Type I, suitable for use on surfaces from 0–850°F, with thermal conductivity 0.23 at 75°F or 0.33 at 250°F, and minimum 3 pcf density. ASJ shall have self-sealing lap at end and along length, with pressure sensitive tape lap sealing system. Owens Corning SSL II Pipe Insulation, Johns Manville Micro-Lok, Knauf Pipe Insulation.

1. Where Type P-1 insulation is used, insulate fittings, valves and accessories using one of the following:

a. Fiberglass pre-formed fitting insulation complying with the specification for P-1 pipe insulation, Johns Manville Hi-Lo Temp insulation inserts, Hamfab, OAE. Finish with Type J-2 fitting covers.

b. Where pre-formed fitting insulation is not available, the following may be used: minimum 0.75 pcf density fiberglass per spec for D-1 insulation except without FSK. Finish with Type J-2 fitting covers or with two coats of fitting mastic with fiberglass fitting tape embedded between coats.

C. Type P-2, Fiberglass Pipe and Tank Insulation: Similar to Type P-1 insulation and jacket, except with fibers oriented to allow insulation to be wrapped onto curved surfaces, with conductivity 0.30 at 100°F, or 0.55 at 400°F. Johns Manville Pipe & Tank Insulation, Owens Corning Pipe and Tank Insulation or Knauf Pipe and Tank Insulation.

1. Alternate: Fiberglass board insulation similar to Type D2, scored for application on curved surfaces, with ASJ.

D. Type P-3, Calcium Silicate Pipe Insulation: Rigid calcium silicate per ASTM C533, Type 1, asbestos-free, suitable for use on piping up to 1200°F, conductivity 0.55 at 700°F, compressive strength min. 200 psi at 5% compression. Industrial Insulation Group OAE.

1. Fittings, valves and accessories: Insulate with mitered Type P-3 insulation or Type D-7 insulation.

E. Type P-4, Elastomeric Foam Pipe Insulation: Pre-formed elastomeric foam, ASTM C534 Type 1 flexible, closed cell, suitable for use up to 220°F, UV protected, not to exceed flame spread 25 and smoke developed 50 based on 0.75-inch thickness, conductivity 0.30 at 75°F. Kflex, Armacell OAE. As an acceptable alternate ITW insulation may be used.

F. Type P-4,-Alternate-Phenolic Foam Insulation: Pre-formed closed cell phenolic foam, ASTM E84 suitable to 250°F, with Saran 540CX or 560CX vapor retarder film and tape, not to exceed

flame spread 25 and smoke developed 50 based for thicknesses up to 3”-inch thickness, conductivity of 0.15 at 75°F.

1. Fittings, valves and accessories: Insulate using either Type P-4 insulation pre-formed for use on fittings and valves, or cut sections of P-4 pipe insulation to match the shape of the fitting or valve, taped on using PVC tape.

2.3 DUCTWORK INSULATION

A. Type D-1, Fiberglass Blanket: Factory fabricated insulation and FSK jacket assembly suitable for applications from 40-250°F, 3/4 pcf fiberglass, ASTM C553 Type I or II, with thermal resistance not less than the following for 2-inch thickness: 6.8 out of the box, 5.6 installed with 25% compression. Johns Manville Microlite XG Duct Wrap, Owens Corning Soft R Duct Wrap, Knauf Friendly Feel Duct Wrap, Certainteed Soft Touch Duct Wrap.

B. Type D-2, Fiberglass Board: Similar to Type D-1 except rigid board type, 3 pcf density, thermal conductivity 0.23 at 75°F, NRC 1.36, suitable for unfaced side at up to 450°F and faced side at up to 150°F. Johns Manville 800 Series Spin Glas, Owens Corning 700 Series Board, Knauf Insulation Board, Certainteed Certra Pro Commercial Board

C. Type D-3, Acoustic Lining (roll type): Organic fiber or fiberglass duct liner bonded with thermosetting resin, with factory-applied acrylic surface coating treated with anti-microbial agent, and factory-applied or shop-applied edge coating.

1. Properties: Minimum 1.5 pcf density, thermal conductivity 0.24, 6000 FPM rated per UL 181, NRC 0.70 at 1-inch thick and .95 at 2-inch thick. The product (fiberglass, resin, coating, microbial agent and adhesive) as an assembly shall be suitable for surfaces and gases up to 250°F, and shall comply with ASTM C1071 (Type I), G21 and G22.

2. Lining surface shall be cleanable using commercially available duct cleaning equipment when performed by qualified technicians using procedures established and recommended by the North American Insulation Manufacturer's Association (NAIMA) Duct Cleaning Guide.

3. Johns Manville Linacoustic RC, Owens Corning Acoustic R duct liner, Knauf EM duct liner, Certainteed ToughGuard R Duct Liner.

D. Type D-4, Acoustic Lining (board type): Similar to Type D-3 and complying with all aspects of the spec for Type D-3 insulation, except 3 pcf density rigid board with NRC 0.75 at 1-inch thick and 1.0 at 2-inch thick. Johns Manville Permacote Linacoustic R-300. Owens Corning Duct Liner Board, Knauf Rigid Plenum Liner, Certainteed Rigid Liner Board.

E. Type D-5, Grease Duct Applications: High temperature, foil-encapsulated inorganic blanket, 8 pcf. Insulfrax Fyre Wrap Max 2.0, Johns Manville Fire Temp, OAE. Product shall meet the following when applied as 2-layers around a grease-duct:

1. Tested and listed for zero clearance to combustibles across the entire surface of the blanket material per internal fire test AC101 or ASTM E2336 - Internal Fire Test – 2 Hr Grease Duct Enclosures.

2. Rated as a 2-hr fire resistive enclosure assembly per ASTM E-119, Engulfment Fire Test for 2-hr Grease Duct Enclosure.

F. Type D-6 –Combustible Materials within Plenum: For use on combustible materials located within supply or return air plenums, foil-encapsulated 8 pcf high-temperature ceramic fiber blanket suitable for service up to 1800°F. Unifrax Fyre-Wrap 0.5 plenum insulation.

G. Type D-7 – Fire Rated Ductwork: Suitable for continuous operation at 1800°F, 6-pcf, foil-encapsulated inorganic blanket to provide a 2-hour rating per ISO 6944 when applied in a single 1.5-inch thick layer. Insulfrax FyreWrap 1.5 OAE.

H. Type D-8 – Polystyrene Insulation: Rigid cellular square edge insulation per ASTM C578, waterproof, thermal conductivity 0.20, compressive strength 25 psi. Dow Styrofoam or Owens Corning Foamular.

I. Type D-9 – Fiberglass Ductboard: Listed per UL 181 as a Class 1 Rigid Air Duct; conforming to ASHRAE Std. 62, NFPA-90A and 90B, ASTM G-21 & G-22; rated for 2-in. wg; constructed of fiberglass bonded with a thermosetting resin, with double density slip joints pre-molded in the board; FSK jacket; thermosetting acrylic polymer interior surface, and black interior surface color. Thermal conductivity 0.23, and NRC 0.70 at 1-inch thick and 1.0 at 2-inch thick. Johns Manville Superduct 475 or 800, Owens Corning Quiet R Duct Board, Knauf Duct Board M, Certainteed ToughGard Duct Board

2.4 EQUIPMENT INSULATION

A. E-1, Removable Insulating Blanket: Factory fabricated, one-piece, removable and re-usable insulating blanket with fiberglass insulation completely enclosed within a silicone coated fiberglass cloth with draw cords of SS or PTFE coated glass fiber, and stainless steel clips. Insulation thickness shall be as specified elsewhere, but not less than 1-inch. Energy Systems Inc. “Q-Master” OAE.

2.5 INSULATION JACKETS

A. Type J-1, Metal Jacket: 0.010-inch smooth Type 304 stainless steel or 0.016-inch smooth or embossed aluminum per ASTM B-209, with minimum 1-mil polyethylene film with protective layer of 40 Lb virgin kraft paper, continuously laminated to full width inside jacket. Childers OAE.

1. Where jacket diameter is 16–96 in: 0.016-in. SS or 0.020 in. aluminum.

2. Equipment heads and all surfaces where jacket is greater than 96-inch OD: 0.020-inch SS or 0.024 inch aluminum.

3. Fittings and Accessories: Provide the same jacket material as for pipe.

B. Type J-2, PVC Jacket: Minimum 20 mil sheets and 30-mil pre-molded fitting covers, ASTM D1784, Class 16354-C. Accessories include solvent weld solution, stainless steel tacks, and tape. All components shall be white, UV resistant, with paintable exterior surface, and suitable

for use at –20 to +150°F. Johns Manville System 2000 (sheets), Zeston 300 (fitting covers), and Perma-Weld (solvent cement), OAE.

C. Type J-3, Canvas Jacket: 10 x 10 fiberglass mesh.

2.6 MISCELLANEOUS PRODUCTS

A. General:

1. Tapes: Aluminum, pressure sensitive, UL 181A-P listed and embossed, minimum 2.5-inch wide, Nashua 324A OAE.

2. Duct Liner Adhesives: Water-based, complying with ASTM C916.

3. Solvent Cement for PVC Jackets: Johns Manville Perma-Weld OAE.

4. Staples: Outward clinching, 0.5-inch galvanized steel

B. Piping Systems:

1. Pipe Hanger Insulation Inserts: Mechanical Pipe Shields Inc. “Snapp Itz” OAE.

C. Ductwork Systems:

1. Duct Liner Edge Sealer, Surface Sealer, Coatings & Adhesives: To meet ASTM C916. Johns Manville Superseal OAE.

2.7 SPECIAL APPLICATIONS

A. Handicap Lavatory Insulation Kit: Handi-Lav-Guard insulation kit per ANSI A117.1 with flexible vinyl finish.

PART 3 - EXECUTION

3.1 GENERAL

A. Delivery, Storage and Handling: Deliver and store insulation materials in factory-supplied containers. Protect from moisture. Do not install any materials that have gotten wet, regardless whether they are subsequently dried.

B. Store and apply materials in accordance with manufacturers’ recommendations, but not less than the following minimum temperatures. Ensure surfaces are clean and dry prior to application, and for minimum two hours after application:

1. Sealers, coatings, solvents and adhesives: 40°F.

2. Tapes 50°F.

C. Install in accordance with manufacturer's recommendations, NAIMA recommendations, and this spec. Provide good ventilation.

D. Where vapor barriers are specified, ensure that the entire system is vapor sealed.

E. Protect materials from water damage. Replace any materials that are water-damaged prior to substantial completion.

3.2 PIPING INSULATION

A. General: Insulate piping as indicated herein and/or on the drawings. Except as noted, insulate all valves, fittings, and accessories with the same material and thickness specified for the pipe. Where piping is specified with a separate insulation jacket provide this same jacket for valves, fittings and accessories. Vapor seal cold piping systems.

1. Where insulation terminates, provide insulating cement beveled for a neat finish. For vaporsealed piping, coat with insulating mastic prior to applying insulating cement.

2. Strainers and Suction Diffusers: Either Type P-1 or P-3 insulation. Make provisions to easily remove and re-install insulation.

3. Pipe Supports: Provide high density calcium silicate insulation or insulation inserts as specified. Maintain pipe jacket and vapor barrier at supports. If necessary, apply a heavy coating of vapor barrier mastic material to prevent condensation from forming on supports. Provide galvanized steel insulation shields to protect insulation and jackets at supports.

4. Penetrations Through Building Construction: Insulation shall be continuous where piping passes through walls, floors, and other construction. Where insulated piping passes through fire and/or smoke rated construction, provide a section of UL approved fire safing insulation to match the required insulation thickness, or provide an insulated pipe sleeve as manufactured by Pipe Shield, Inc., OAE.

5. Mechanical Couplings: Where mechanical couplings are permitted, insulate them as specified for fittings.

6. Steam Traps: Do not insulate.

7. Retrofit Projects: Match the thickness of existing insulation where new insulation adjoins existing. Integrate new vapor barrier with existing so the insulation barrier is continuous for both new and existing piping.

8. All voids formed by support saddles or other mounting or support hardware shall be filled with insulation.

B. Application:

Temp Range	Temp (F)	Insulation Type	Vapor Sealed	Pipe Size				
				Under 1	1 & 1.25	1.5 - 3	4 & 6	8 & Larger
TR-1	60&Less	P-1 or P-4	Yes	0.5	1.0	1.0	1.0	1.5
TR-2	61 - 104	P-1	Yes	0.5	0.5	0.5	0.5	0.5
TR-3	105 - 140	P-1	No	0.5	0.5	1.0	1.0	1.0
TR-4	141 - 200	P-1	No	1.0	1.0	1.0	1.5	1.5
TR-5	201 - 250	P-1	No	1.5	1.5	2.0	2.0	2.0
TR-6	251 - 350	P-1	No	1.5	2.5	3.0	3.0	3.0
TR-7	Over 350	P-1	No	2.5	3.0	3.0	4.0	4.0

1. Temperature Range TR-1: Chilled water, refrigerant suction, condenser water (outdoor piping subject to freezing).

2. Temperature Range TR-2: Domestic cold water, makeup water, soft water, industrial water, process water of any type, non-potable water, HVAC make-up water (except insulation is not required for evap cooler makeup piping outdoors), interior horizontal roof drain and overflow bowls and piping, condensate drains indoors.

3. Temperature Range TR-3: Domestic hot water (except non-circulating HW within interior walls and chases) and domestic HW return except as noted.

4. Temperature Range TR-4: Heating water supply and return, low pressure steam condensate, pumped condensate return, engine cooling water.

5. Temperature Range TR-5: N/A

6. Temperature Range TR-6: N/A

7. Temperature Range TR-7: N/A

C. Special Applications

1. Handicap Lavatories: Insulate domestic hot and cold water piping and P-traps exposed below handicapped lavatories with insulation kit specifically designed for the application.

2. Heat Traced Piping: Oversize insulation as required to accommodate heat tracing. Provide metal jacket.

3. Plastic pipe in return air plenums: Provide 0.5-inch type D6 insulation.

4. Piping subject to freezing and heat traced piping: Insulate all such piping (including drain piping) with thicknesses specified, but not less than 1.5-inch thickness. Oversize insulation to accommodate heat tracing where indicated. Provide J1 jacket.

D. Type P-1 & P-2, Fiberglass Insulation: Install in accordance with manufacturer's recommendations.

E. Type P-3, Calcium Silicate Insulation: Adhere to pipe or equipment using stainless steel wire. Provide removable J-1 jacket.

F. Type P-4, Elastomeric Foam: Seal all butt ends and longitudinal joints with Halstead Adhesive. When exposed to the weather, protect flexible tubing insulation with two coats of exterior weatherproof coating as recommended by manufacturer.

G. Jacketing: In addition to the finish and jacket specified for the particular type of insulation, provide the following:

1.	Indoor piping exposed to physical damage	Type J-2, PVC
2.	Mechanical Eqpt Spaces: Exposed piping less than 8 ft above floor or operator platform	Type J-2, PVC
3.	Exterior piping	Type J-1, Metal

3.3 DUCTWORK INSULATION

A. General:

1. Insulate all ducts except those specified to be uninsulated. The following ductwork need not be field insulated:
   a. Factory insulated ductwork and plenums.
   b. Ducts with acoustic lining, provided the lining thickness matches or exceeds the required insulation thickness.
   c. Exhaust ducts, except where noted.
   d. Return air ducts, except where noted.
2. See Table 23 0700-1 for additional information.
3. Ensure that ductwork is leakage tested prior to applying insulation. Inspect ductwork and repair any deficiencies prior to applying insulation. Do not apply insulation over deficient ductwork or plenum construction.
4. Ensure that ductwork is clean and dry before applying insulation.
5. For ductwork with acoustic lining the drawings indicate the "clear inside duct dimension" required. Over-size ducts as required to provide the required air flow area.

B. Type D-1, Fiberglass Blanket Insulation: Measure and cut insulation. Install so insulation is not excessively compressed at corners. For rectangular and flat oval ducts 24-inches and wider, provide stick pins and speed clip washers 18-inches on centers on the bottom, and clip off excess length of stick. Firmly butt insulation ends and longitudinal joints. Overlap jacket minimum 2-inches at end joints and longitudinal joints, staple on 6-inch centers, and continuously seal jacket. Provide vapor barrier mastic where ducts are indicated to be vaporsealed. Should gaps or fishmouths occur, re-staple and seal them with mastic. Use FSK tape and vapor barrier mastic to seal all penetrations of the FSK jacket, such as pins, tears, and

hangers. Neatly trim and seal insulation at access doors, ends, damper rod controls etc. Verify proper damper operation.

C. Type D-2, Fiberglass Board Insulation: Attach with mechanical fasteners 12" on centers.

D. Type D-3 & D4, Acoustic Lining: Ductwork dimensions indicated on the drawings are net air flow dimensions inside liner. Increase duct size to accommodate liner. Completely line the inside surfaces of ducts and plenums specified and indicted. Comply with the NAIMA Fibrous Glass Duct Liner Standard (FGDLS), manufacturer's recommendations, and this spec. Adhere liner with minimum 90% coverage of adhesive, and secure with mechanical fasteners and washers per FGDLS and manufacturer's recommendations. Fastener length shall be sufficient to limit compression of liner to 1/8" maximum. Coat all cut edges and surface penetrations with edge sealer. Provide metal nosing for liner leading edges at fan discharge and for all ducts with air velocities exceeding 3,000 FPM. Maintain minimum 18-inch clearance from electric resistance heaters. Interrupt liner at dampers and apply external insulation at these locations.

E. Type D-5: Install insulation in a 2-layer system per manufacturer's instructions, including the use of mechanical fasteners for the underside of ducts, butting or overlapping of joints, and offsetting of joints on outer layer.

F. Type D-6: Install in accordance with manufacturer's instructions. Overlap seams and joints minimum 2-inches, affix with SS wire minimum 18-inches on centers, but not less than per manufacturer's recommendations, and tape seams and joints with aluminum tape.

G. Type D-7: Install insulation in a single-layer system per manufacturer's instructions. Mechanical fasteners for the underside of ducts shall be adhered to the duct in a manner suitable for the operating temperatures (welded or other suitable method). Butt or overlap joints per manufacturer's recommendations.

H. Type D-8: Wire in place with SS wire minimum 12-inches on centers, and provide J-1 jacket.

I. Type D-9: Install per manufacturer's recommendations, NAIMA standards, and SMACNA Fibrous Glass Duct Construction Standards. Provide ship lap seams and joints.

3.4 EQUIPMENT INSULATION

A. General: Where specified elsewhere, equipment will be factory insulated. Insulate all equipment as noted herein except portions of equipment that are factory insulated.

1. Fiberglass Board Insulation: Score, bevel, or miter to provide tight joints and secure in place with mechanical pin and clip fasteners and insulation bonding adhesive applied to underside surfaces, or with bands. Fill joints with insulation material and provide corner beads to protect edges of insulation.

2. Cold Tanks and Equipment: J3 jacket with two coats of approved vapor barrier mastic.

3. Factory Packaged Equipment: Field insulate the equipment and piping on factory-fabricated assemblies as if they were field installed, unless such items are factory insulated.

B. Storage Tanks: 2-inch type P2.

3.5 JACKETING

A. Type J-1, Metal Jacketing:

1. Ducts: Slope jacketing to shed rain.

2. Pipes: Install with seams at the 3 o'clock or 9 o'clock position to shed water. Band 12" on centers.

3. Joints and Seams: Overlap joints minimum 2-inches. Caulk with a weatherproof caulk when located outdoors.

B. Type J-2, PVC Jacketing: Secure in place with tacks and solvent welded joints. White PVC tape may be used indoors.

C. Type J-3, Canvas Jacket: Apply mastic at a rate of 60 to 70 sq. ft. per gallon, embed fiberglass mesh, smooth all wrinkles and apply finish coat of Sealfas, or equivalent.

3.6 SPECIAL APPLICATIONS

A. Boiler Breeching and Stacks: Provide 3" thick Type P1 or P2 insulation with Type J1 metal jacket.

B. Engine Exhaust Systems: Insulate all components within engine exhaust systems including exhaust pipe and silencer, but do not insulate flexible connectors. Use either 4-inches of Type P3, or 2-inch Type P3 adjacent to surface, followed by 2-inch Type P1. Affix Type P3 insulation with SS wire. Provide Type J-1 jacket.

END OF SECTION 23 0700

TABLE 23 0700-1 – DUCTWORK INSULATION

Service	Location	Condition	Insulation Type	Insulation Thickness (in)	Notes
Supply Air, Makeup Air, Exhaust/Relief Air and Outside Air.	Indoor	Concealed	D1	1.5	1, 3
Supply Air, Makeup Air, Exhaust/Relief Air, and Outside Air.	Indoor	Exposed	D2	1.5	
Supply Air, Makeup Air, Exhaust/Relief Air, and Outside Air.	Outdoor	All	D8	2	5, 6, 7
Supply Rectangular Ductwork downstream of Low Velocity MZU's, AHU's, and RTU's	Indoor	All	D1	1	1
Return Rectangular Ductwork upstream of MZU's, AHU's, and RTU's	All	All	D1	1	2
Ductwork indicated to be lined	All	All	D3	1	
Ductwork indicated to be lined with 2-inch acoustic lining	All	All	D3 or D4	2	
Single Wall Lined Plenums	All	All	D4	2	
Transfer Air Ducts	All	All	D3 or D9	1	
Exhaust Ductwork	Indoor	Concealed	D1	1.5	4
Exhaust Ductwork	Indoor	Exposed	D2	1.5	4
Kitchen Exhaust Ductwork	Indoor	All	D5	2-layers	
Plastic Piping and Ductwork within RA Plenums	Indoor	Concealed	D6	0.5	
Fire-Rated Ductwork Other than Kitchen Exh	Indoor	All	D7	1.5	

Notes:

1 Lag 30 feet of all supply air duct from each MZU zone discharge. Lagging material shall be applied on the outside of the duct and shall be manufactured by Sound Seal B-10 LAG/QFA-9 with STC rating of 30 and comply with ASTM E84. Delete Type D3 insulation where lagging occurs.

2 Lag 30 feet of all return air duct to each MZU located outside of fan room. Lagging material shall be applied on the outside of the duct and shall be manufactured by Sound Seal B-10 LAG/QFA-9 with STC rating of 30 and comply with ASTM E84..

3 Vaporseal ducts conveying cold air.

4 Insulate only the portion of exhaust ductwork between isolation damper and outside.

5 Provide J1 Jacket.

6 Seal outdoor ductwork to prevent ingress of moisture.

7 Provide acoustical liner in supply and return air ducts.

SECTION 23 0810 - PERFORMANCE ASSURANCE CONTRACTOR OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, general project requirements and Division 01 Specification Sections, apply to this Section. Note in particular the following sections containing related requirements:

1. General Conditions – Article 6: Contractor's responsibilities to cooperate and coordinate with Owner's separate contractors.

2. Section 01 3100 – Project Management and Coordination: Coordination of Performance Assurance work; inclusion in Project Schedule.

3. Section 01 4000 – Quality Requirements: **Performance Assurance Contractor's (PAC)** services and reports; Contractor's responsibilities.

4. Section 01 7500 – Starting and Adjusting: Coordination with PAC requirements.

5. Section 01 7700 – Closeout Procedures: Coordination with PAC requirements.

6. Section 01 7800 – Closeout Submittals - Coordination with PAC requirements.

7. Section 01 7900 – Demonstration and Training

8. Section 25 0593 – Testing, Adjusting, and Balancing

1.2 SCOPE OF WORK

A. This section includes Owner's separate Performance Assurance Contractor (PAC) process requirements related to HVAC systems, assemblies, and equipment. The Contractor shall provide the necessary labor, instrumentation, tools and equipment for this portion of the Work.

1.3 DEFINITIONS

A. **Performance Assurance Contractor:** Performance Assurance Contractor Authority: An independent consultant, not otherwise associated with the Design Professional team members or the Contractor who is hired by, and reports directly to the Owner in accordance with Article 6 of the General Conditions.

1.4 CONTRACTOR'S SUBMITTALS

A. General: Comply with the provisions of the General Conditions of the Contract and Division 01 specification sections.

B. Product Data: Submit directly to Design Professional and Owner, with copies to PAC:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports required by PAC requirements on Project.

2. Identification of installed systems, assemblies, equipment, and components, including design changes that occurred during construction.

3. Process description and schedule for completing Construction Checklists and manufacturer's pre-start and start-up checklists for HVAC systems, subsystems, equipment, and components to be tested.

4. Construction Checklists certifying that the HVAC systems, sub-systems, equipment, and associated controls are installed complete, operational and ready for testing.

5. Test and inspection reports and certificates.

6. Corrective action documents with follow-up and results.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Equipment required for start-up, checking, and testing shall be calibrated within the past year and in accordance with the manufacturer's recommendations.

PART 3 - EXECUTION

3.1 CONTRACTOR'S RESPONSIBILITIES

A. Upload requested information and submittals to PSFA CIMS including, but not limited to:

1. Performance data

2. Capacity information

3. Sequence of operations

4. Factory performance tests

5. IOM manuals

B. Complete pre-functional checklists (PFC's) as directed by the Performance Assurance Contractor.

C. Perform functional performance testing (PFT's) as directed by the Performance Assurance Contractor.

D. Attend construction phase controls coordination meeting.

E. Attend testing, adjusting, and balancing review and coordination meeting.

F. Participate in HVAC systems, assemblies, equipment and component maintenance orientation and inspection as directed by the Performance Assurance Contractor.

G. Provide information requested by the PAC for final PAC documentation.

3.2 CONTRACTOR'S TESTING PREPARATION

A. Certify HVAC systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify HVAC instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

D. Inspect and verify the position of each device and interlock identified on checklists.

1. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

E. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the Performance Assurance Contractor.

3.3 CONTRACTOR'S GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform Performance Assurance tests at the direction of the Performance Assurance Contractor.

B. Scope of HVAC testing shall include entire HVAC installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The Performance Assurance Contractor shall prepare detailed testing plans, procedures, and checklists for HVAC systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments.

Provide equipment to simulate loads. Set simulated conditions as directed by the Performance Assurance Contractor and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The Performance Assurance Contractor may direct that set points be altered when simulating conditions is not practical.

H. The Performance Assurance Contractor may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC SYSTEMS, SUB-SYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Boiler Testing and Acceptance Procedures: Contractor shall provide submittals, test data, inspector record, and boiler certification to the Performance Assurance Contractor.

B. HVAC Instrumentation and Control System Testing: Contractor shall assist the Performance Assurance Contractor with preparation of testing plans.

C. Contractor shall prepare an HVAC-associated pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the Performance Assurance Contractor. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.

2. Description of equipment for flushing operations.

3. Minimum flushing water velocity.

4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested and chemically treated.

D. Refrigeration System Testing: Contractor to provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The Performance Assurance Contractor shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

END OF SECTION 23 0810

SECTION 23 0900 - FACILITY MANAGEMENT SYSTEM

PART 1 - GENERAL

1.1 REQUIREMENTS

A. The entire Facility Management System (FMS) specified hereafter shall be approved and listed by Underwriters' Laboratories, Inc., under UL 916 (Standard for Open Energy Management Equipment).

1.2 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements for HVAC.

B. Section 23 0505, Piping Specialties.

C. Section 23 0523, Valves.

D. Section 23 0549, HVAC and Electrical Installation Coordination.

E. Section 23 0550, Variable Frequency Drives.

F. Section 23 0593, Testing, Adjusting and Balancing.

G. Section 23 0800, Commissioning.

1.3 SCOPE

A. It is the intent of this Section to provide, install, connect, and calibrate the entire Facility Management System (FMS) as indicated on the Drawings and as necessary to provide fully automatic control for all systems as shown in the control drawings, stated in the sequences of operation, indicated in the electrical ladder diagrams, or as otherwise indicated in the Contract Documents. Some equipment controls may be specified to be provided in the Contract Documents outside this Section. As work of this Section, the Contractor shall coordinate with these other suppliers and trades to provide a completely integrated control system.

B. It is the responsibility of the bidder to read and conform to all sections of the Specifications, review all Contract Drawings of all Divisions, and coordinate with all equipment suppliers of material specified under other sections of the Specifications including any Owner-furnished equipment.

1. The engineering, installation supervision, programming, graphics development, calibration, startup, and checkout necessary for a complete and fully operational control system as specified hereafter shall be provided under this Section.

C. Provide startup documentation verifying proper operation of all points and all integrated systems.

D. Provide integration of electrical power systems, VFD's, and boilers into the FMS as outlined on the drawings, in the sequence of operations, or in the specifications.

E. Provide training and instruction of the installed control system.

1.4 APPROVED MANUFACTURERS

A. Facility Management System suppliers will be authorized factory representatives or branch offices of Alerton, Automated Logic, or Honeywell.

1.5 SUBMITTALS

A. Within thirty (30) days of contract award, submit shop drawings and submittal data in accordance with Section 23 0500 and the General Contract Requirements. These submittals shall be delivered first to the mechanical and electrical sub-contractors for coordination review and evaluation prior to being submitted for final review. Letters from these sub-contractors verifying that they have reviewed the submittals, and any comments regarding the submittals, must be attached as part of the final submittal.

B. Submittals shall consist of shop drawings, catalog data sheets, and point verification forms as defined in the following paragraphs.

1. Shop drawings shall be provided which show all control devices, electrical ladder diagrams, control system schematics, sequences of operation, and a material list. All systems and the associated control components, as well as all connections between components, shall be clearly indicated. The submittal shall clearly indicate the required coordination with equipment supplied by others, including any Owner-furnished equipment. Simply showing a connection with no identification or termination will be considered unacceptable. All connections shown on the Drawings shall be labeled on both ends and these same labels shall be used for the installation process for ease of comparing the shop drawings to the actual field installation. Each control component shall be given a unique identifier. This identifier shall be used in the sequence of operation so that reference to the Drawings can be easily made. A complete FMS communication and power architecture drawing shall also be included on the shop drawing.

    a. Electrical ladder diagrams shall be shown on the shop drawings. Electrical ladder diagrams shall show all switches, relays, motor starters, etc. The electrical ladder diagrams shall show the correct control wiring and interlock wiring of all equipment provided under the Contract including any Owner-furnished equipment. Each diagram shall reference the correct power source by breaker panel and circuit number or from a control transformer. If equipment shown is provided by another Contractor, then this shall be noted.

    b. The sequence of operation for each controlled system shall be provided with reference to the control device identifier. The sequence of operation shall break down the control operation by major function (i.e., mixed air control, occupied-unoccupied, smoke purge, etc.,) and describe in detail the correct operation and interaction with other system functions. Use of the sequence of

operation stated on the Drawings is acceptable; however, it shall be modified to reflect actual control device identifiers.

c. A complete material listing shall be included on the shop drawings which show the device model numbers, device identifiers, quantities, manufacturers, etc., of all equipment provided under this Section. The material list shall be organized in alphabetical order so that it can be easily compared to the associated catalog data sheets. The quantities are to be provided only to confirm a general understanding of the contract requirements and will not be verified as a complete material list.

2. Catalog data sheets will be provided for each different piece of equipment provided under this Section. At a minimum the data sheet shall contain sufficient information so that compliance with the Specification can be verified. Where multiple models or options are indicated on the same catalog data sheet, the equipment proposed shall be highlighted or otherwise indicated. The catalog data sheets shall be organized in alphabetical order to match the material listing on the shop drawings.

3. An integration plan shall be provided for each system being integrated into the FMS. The plan shall contain all systems, points, descriptions, addresses, and default values to be integrated. The contractor shall work with the system providers to compile this information prior to connection of the system to the FMS. This plan shall be submitted and approved by the Owner/Engineer before integration occurs.

4. Point verification forms shall be completed for all points that will be installed as part of the FMS. Once approved, these forms shall be used during the testing and startup portions of this work. A template point verification form is located at the end of this Section.

5. All Graphic Slides (or typical graphics for identical equipment) proposed for use on this Project shall be submitted for review and approval. The submitted slides shall be printed in color. All realtime display fields, user input fields, etc., shall be clearly indicated. No graphic software shall be installed on the job site until the Graphic Slides have been approved.

6. Software Development parameters including all trend logs, reports, point alarm parameters, passwords, and scheduling shall be submitted based on the contents of this Specification Section. The information contained in this portion of the submittal will be followed during development of the programming code and shall be used for evaluation of the system's performance during the commissioning phase.

   a. Report templates shall indicate what information will be presented on each report, how the information will be presented, report hard disk upload parameters, and report log file names.

   b. If user authentication is required in any part of the installed system blank forms shall be submitted for completion of user information by the Owner. The forms shall allow the Owner to fill in the operator's name and approved password level. During Owner training, the FMS programmers shall coordinate with the approved operators to allow the operators to input their private passwords.

   c. Blank schedule forms for each air handling system shall be submitted for completion by the Owner. Additionally, a blank schedule group form template

shall be submitted so the Owner can identify schedule groups of HVAC equipment.

7. The names, phone numbers, e-mail addresses, job descriptions, pager numbers, mobile phone numbers, etc., shall be provided for the project manager, project engineer, project programmer(s), installation foreman, and any other individuals key to the completion of this project. If at any time during the project the assignment of personnel changes, the Owner and the Engineer shall be notified and the previously listed information shall be furnished for the newly assigned individuals.

C. All re-submittals shall contain a cover letter restating all of the previous submittal comments made by the reviewing engineer along with a written statement by the Contractor as to the resolution of each item. Any re-submittal issued to the engineer without this cover letter will result in an automatic rejection of the submittal.

1.6 RECORD DRAWINGS

A. Record drawings shall be provided as required by Section 23 0500 and the General Contract Requirements. Record drawings shall not be completed until after installation is complete. Any changes made during installation shall be recorded on the approved shop drawings as they are made so that a current record drawing is constantly being updated. These as-constructed drawings shall be available at all time for inspection by the Owner's Representative. At completion of the project, all manual changes shall be incorporated into a clean reproducible set of as constructed drawings. These as-constructed drawings shall be available for use during the training sessions.

B. With the reproducible record drawings the Contractor shall furnish a complete spare parts lists, operating instructions, and maintenance literature, for proper maintenance of all control equipment, in accordance with the requirement specified in Section 23 0500.

C. In addition to the record drawings, the following documents and manuals will be delivered to the Owner. Two (2) sets of these documents will be provided prior to training begins:

1. Names, address and 24-hour telephone numbers of Contractors installing equipment, and the control systems and service representative of each.

2. Operators Manual with procedures of operating the control systems including logging on/off, alarm handling, producing point reports, trending data, overriding computer control, and changing set points and other variables.

3. Programming Manual with a description of the programming language including syntax, statement descriptions including algorithms and calculations used, point database creation and modification, program creation and modification, and use of the editor.

4. Engineering, Installation and Maintenance Manual(s) that explains how to design and install new points, panels, and other hardware; preventative maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.

5. A listing and documentation of all custom software created using the programming language including the point database. One set of magnetic media containing files of the software and database shall also be provided.

6. One set of electronic media containing files of all color-graphic screens created for the project.

7. Complete original issue documentation, installation, and maintenance information for all third party hardware provided including computer equipment and sensors.

8. Complete original issue media for all software provided including operating systems, programming language, operator workstation software, and graphics software.

9. Licenses and warranty documents for all equipment and systems.

10. Recommended preventive maintenance procedures for all system components including a schedule of tasks, time between tasks, and task descriptions.

D. Training Materials: The Contractor shall provide a course outline and training material for all training classes at least six weeks prior to the first class. The Owner reserves the right to modify any or all of the training course outline and training materials. Review and approval by Owner and Engineer shall be completed at least 3 weeks prior to first class.

E. Operation and Maintenance Manuals: An updated as-built version of the control drawings and sequences of operation shall be included in the final equipment O&M manual submittal. The control drawings shall include:

1. A key to all abbreviations.

2. Graphic schematic depictions of the systems and each component.

3. Schematic system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.

4. A full points list with at least the following included for each point:
   a. Controlled system
   b. Point abbreviation
   c. Point description (dry bulb temp, airflow, etc.)
   d. Display unit
   e. Control point or setpoint
   f. Monitoring point
   g. Intermediate point
   h. Calculated point

5. Detailed sequences of operation for each piece of equipment. They shall include, as applicable:

a. An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.

b. All interactions and interlocks with other systems.

c. Detailed delineation of control between any packaged controls and the building management system, listing what points the BMS monitors only and what BMS points are control points and are adjustable.

d. Written sequences of control for packaged controlled equipment. Equipment manufacturers' stock sequences may be included. Provide additional narrative where needed.

e. Start-up, warm-up mode, normal operating, emergency operating and shutdown sequences.

f. Capacity control sequences and equipment staging.

g. Temperature and pressure control: setbacks, setups, resets, etc.

h. Detailed sequences for all control strategies, e.g., optimum start/stop, staging, optimization, demand limiting, etc.

i. Effects of power or equipment failure with all standby component functions.

j. Sequences for all level of alarms and emergency shut downs.

k. Seasonal operational differences and recommendations.

l. Initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by the operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.

F. After final occupancy and all debugging have occurred, the Contractor shall prepare two (2) copies of all control software on non-volatile magnetic media and deliver them to the Owner.

1.7 SYSTEM TESTING

A. The controls contractor shall prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout and adjust the control system prior to and during functional performance testing. At minimum, the plan shall include for each type of equipment controlled by the automatic controls:

1. System name.

2. List of devices.

3. Step-by-step procedures for testing each controller after installation, including:

a. Process of verifying proper hardware and wiring installation.

b. Written program of sequence for BAS devices and controllers

c. Process of downloading programs to local controllers and verifying that they are addressed correctly.

d. Process of performing operational checks of each controlled component.

e. Plan and process for calibrating valve and damper actuators and all sensors.

f. A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.

4. A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor or controller has "passed" and is operating within the contract parameters.

5. A description of the instrumentation required for testing.

6. Indicate what tests on what systems should be completed prior to Testing, Adjusting and Balancing (TAB) using the control system for TAB work. Coordinate with the Owner and TAB contractor for this determination.

B. Upon completion of the checkout of each controlled device, equipment and system prior to functional testing for each piece of equipment or system, provide a signed and dated certification to the Owner and GC that all system programming is complete as to all respects of the Contract Documents, except functional testing requirements.

C. List and clearly identify on the as-built duct and piping drawings the locations of all static and differential pressure sensors (air and water pressure).

D. At the termination of the testing period, the Contractor shall provide completed point verification sheets for each point in the FMS. These sheets shall be included as a part of the closeout notebook described in Section 23 0900-3.3-7. An example of a point verification form is included in Appendix C.

E. Trend logs and graphs shall be developed as described in Section 23 0900-3.3-7 and Appendices A and B. Completed trend requirements shall be compiled into organized notebook(s) and delivered to the Engineer for approval before the final inspection and close-out of the project is performed.

F. The Owner reserves the right to participate in or assign a representative to participate in the startup, testing, programming, or any other aspect of the construction of this project at no additional cost to the Owner.

1.8 TRAINING

A. The controls contractor shall have the following training responsibilities, in addition to any listed in Division 1:

1. The standard operating manual for the system and any special training manuals will be provided for each trainee, with three extra copies left for the Owner. In addition, copies of the system technical manual will be demonstrated during training and one copy submitted with each O&M manual. Manuals shall include detailed description of the subject matter for each session. The manuals will cover all written control sequences and have a definitions section that fully describes all relevant words used in the manuals and in all software displays. Manuals will be approved by the Owner. Copies of audiovisuals shall be delivered to the Owner.

2. The training will be tailored to the needs and skill-level of the trainees.

3. The trainers will be knowledgeable on the system and its use. For the on-site sessions, the most qualified trainer(s) will be used. The Owner shall approve the instructor prior to scheduling the training.

4. There shall be three training sessions:

   a. Training I. Class Room. The first training shall consist of 8 hours of actual training. This training shall be held on-site. If held off-site, the training may occur prior to final completion of the system installation. Upon completion, each student, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.

   b. Training II. Hands -On. The second session shall be held on-site for a period of 8 hours of actual hands-on training after the completion of system QA. The session shall include instruction on:

      1) Specific hardware configuration of installed systems in this building and specific instruction for operating the installed system, including HVAC systems, lighting controls and any interface with security and communication systems.

      2) Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that CAN be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.

      3) All trending and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends. Trainees will actually set-up trends in the presence of the trainer.

      4) Every screen shall be completely discussed, allowing time for questions.

      5) Use of keypad or plug-in laptop computer.

      6) Use of remote access to the system via phone lines or networks.

   c. Training III. The third training will be conducted on-site six months after occupancy and consist of 4 hours of training. The session will be structured to address specific topics that trainees need to discuss and to answer questions concerning operation of the system.

B. The FMS supplier shall provide 20 hours total of on-line user support to assist the Owner in operating his system during the warranty period (this is not to be used to troubleshoot system problems unless said problems have to do with user programming) and 4 hours a month of additional on-site training during the warranty period. The Owner shall receive monthly statements indicating hours of on-line support used by which operators and for what purpose.

1.9 SERVICE AND WARRANTY

A. The system supplier shall maintain a local maintenance support facility complete with system technicians, diagnostic and test equipment, and new spare components. Emergency service shall be available in the local office on a 24-hour, 7-day a week basis. The service agent shall provide a continuously monitored local service telephone number for emergency service and this number shall be provided to the Owner.

B. Warranty all work as follows:

1. Labor & materials for control system specified shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. Control System failures during the warranty period shall be adjusted, repaired, or replaced at no charge or reduction in service to the Owner. Service during this period shall be available within 12-hours from the time the trouble call is placed.

2. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of warranty.

3. Operator workstation software, project specific software, graphics, database, and firmware updates shall be provided to the Owner at no charge during the warranty period. Written authorization by Owner must, however, be granted prior to the installation of such changes.

4. The system provider shall provide a web-accessible system and support on-line resource that provides the Owner access to a question/answer forum, graphics library, user tips, upgrades, and manufacturer training schedules.

1.10 OWNERSHIP OF PROPRIETARY MATERIAL

A. All project-developed hardware and software shall become the property of the Owner. These items include but are not limited to:

1. Project graphic images

2. Record drawings

3. Project database

4. Project-specific application programming code

5. All documentation

1.11 PROGRESS PAYMENTS

A. When developing a schedule of values for the FMS and control systems, a minimum of 20% shall be reserved for activities after construction completion, including commissioning support,

testing (functional performance testing and trend logs as required herein), record drawings, training, etc. Payment for these activities may be requested as they are completed.

PART 2 - PRODUCTS

2.1 GENERAL

A. All products required for this project shall be selected in accordance with this part of the Section. Installation of the components shall be in accordance with Part 3 of the Section. If a component is required to meet the requirements shown on the Drawings and is not specified in the Part of the Specification, the supplier shall select and submit on components that meets all design requirements indicated on the Drawings, stated in the sequence of operation, and elsewhere in the Contract Documents.

2.2 PRIMARY OPERATOR WORKSTATIONS

A. No new primary operator workstation is required as part of this project. The existing district primary operator workstation server will be used for operator interaction. All new controllers shall be connected to the existing FMS network for connection to the primary operator workstation.

2.3 FMS CONTROLLERS

A. General

1. Standalone FMS controllers shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors. Each standalone FMS controller shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules, volatile and non-volatile memory, signal conditioners, etc.

2. The FMS controllers shall have UL-916 or equivalent CSA or ETL listings. The FMS/FMS field modules shall also conform to FCC Docket 20780, Part 15, Subparagraph B.

3. The FMS controllers shall be fully compliant with ANSI/ASHRAE Standard 135-2012 BACnet and all published addenda at the time of installation.

B. Hardware Requirements

1. Communications

a. Each FMS Controller shall be equipped with the necessary hardware to permit connection to the FMS local area network described in this Section. All communications hardware shall be part of the standard manufactured product and no intermediary devices to establish communications shall be permitted.

2. Memory

   a. Each FMS Controller shall have sufficient memory to support its own operating system and databases including:

      - Control processes.
      - Energy management applications.
      - Alarm management.
      - Historical/trend data for all points.
      - Maintenance support applications.
      - Custom processes.
      - Operator I/O.
      - Dial-up communications.
      - Manual override monitoring.

   b. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

   c. Should FMS controller memory be lost for any reason, the panel will automatically receive a download via the local area network, phone lines, or connected computer. In addition, the user shall have the capability of reloading the FMS controller via the local area network, via the local RS-232C port, or via telephone line dial-in.

3. Input/Output

   a. Each FMS controller shall support inputs and outputs of the following types:

      - Type C digital inputs.
      - SPDT digital outputs.
      - Universal analog inputs which support all industry standard signals including 4-20 mA, 0-20 ma, 0-10 VDC, etc.
      - Universal analog outputs which support all industry standard signals including 4-20 ma, 0-20 ma, 0-10 VDC, etc.
      - Pulse Type C digital inputs.
      - SPDT pulsed digital outputs.

4. Communication Ports

   a. FMS controllers shall provide at least one RS-232C serial data communication ports for simultaneous direct connection of operator I/O devices including portable operator terminals (future) and printers. FMS controller shall allow connection to the serial ports without interrupting the normal operation of permanently connected modems, printers, or network terminals.

5. Override Switches

   a. Onboard hand/off/auto operator override switches shall be provided integral to the FMS controller for digital output points and positioning switches for all analog output points. The FMS controllers shall monitor the status or position of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited.

6. Status Indicators

   a. The FMS controller shall have local status indication for each binary input and output without the need for an operator I/O device.

7. Surge and Transient Protection

   a. Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standard 587-1980.

8. Expandability

   a. The system shall be modular in nature, and shall permit expansion through the addition of workstation hardware, FMS controllers, sensors, and actuators.

9. On-Line Diagnostics

   a. Each FMS controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of onboard electronics. The FMS controller shall provide both local and remote enunciation of any detected component failures or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each FMS controller, and shall not require the connection of an operator I/O device.

10. Power Failure Restart

    a. In the event of the loss of normal power, there shall be an orderly shutdown of all standalone FMS controllers to prevent the loss of database or operating system software. Upon restoration of normal power, the FMS controller shall automatically resume full operation without manual intervention.

C. Software Requirements

1. General

   a. All necessary software to form a complete operating system as described in this Specification.

   b. All software routines and programs specified in this Section shall be provided as an integral part of the FMS controller and shall not be dependent upon any higher level computer for execution.

2. PID Control

   a. The FMS controllers shall perform full proportional, integral, derivative (PID) control with all PID loops having the automatic control loop tuning feature.

3. Minimum Runtimes

   a. The control software shall include a provision for all digital outputs to have minimum on/off cycle filters.

4. Staggered Starts

   a. The control software shall include a provision for all digital outputs to electrical

demand base start filters to prevent excessive electrical demand on the startup of equipment.

5. Automatic Restart

   a. After an interruption of normal power, the FMS controller shall analyze the status of all controlled equipment, compare it with the commanded position and return all equipment ON or OFF as necessary to resume normal operation.

6. Energy Management Applications

   a. The FMS controllers shall have the ability to perform all of the following energy management routines as standard sub-routines which do not require the application of customized software:

      - Time of day scheduling.
      - Calendar-based scheduling.
      - Holiday scheduling.
      - Temporary schedule overrides.
      - Optimal start.
      - Optimal stop.
      - Night setback control.
      - Enthalpy switchover (Economizer).
      - Peak demand limiting.
      - Temperature compensated duty cycling.
      - Chiller sequencing.

   b. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow operator customization. Programs shall be applied to building equipment as described in the Sequence of Operation.

D. Custom Programming

1. The FMS controllers shall be able to execute custom, job-specific processes defined by the operator, to automatically perform calculations and special control routines.

2. There shall be no restriction as to the ability of the operator to create any type of control logic using system inputs, calculated variables, Boolean Logic, etc.

3. The software shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified primary operator station or printer, buffer the information in a follow-up file, or cause the execution of a dial-up connection to a remote operator workstation.

E. Alarm Management

1. Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each FMS controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the FMS controller's ability to report alarms be affected by either operator activity at

an Operator Workstation or local I/O device, or communications with other panels on the network.

2. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three (3) priority levels shall be provided. Each FMS controller shall automatically inhibit the reporting of selected alarms during system shutdown and startup. Users shall have the ability to manually inhibit alarm reporting for each point.

3. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 65-character alarm message to more fully describe the alarm condition or direct operator response.

4. Each FMS controller shall be capable of storing a library of at least 250 alarm messages. Each message may be assignable to any number of points in the panel.

F. Report Routing

1. Alarm reports, messages, and files will be directed to a user-defined list of devices or disk files used for archiving alarm information.

G. Operator Log

1. Operator commands and system events shall be automatically logged to disk in personal computer industry standard database format. Operator commands initiated from direct-connected workstations, dial-up workstations, and local FMS controller network terminal devices shall all be logged to this transaction file. This data shall be available at the Operator Workstation. In addition, this transaction file shall be accessible with standard third party database and spreadsheet packages. The user shall also be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.

H. Trend Analysis

1. The FMS controllers shall be capable of storing point history files for every analog and binary input and output at the same time. The point history routine shall continuously and automatically sample the value of all analog inputs at user definable intervals.

2. The FMS controllers shall also provide high resolution sampling capability in one-second increments for verification of control loop performance.

3. Trend data for the FMS controller as well as all associated ASCs and TCUs shall be stored at the FMS controllers, and uploaded to hard disk storage at the operator workstation when archival is desired. Uploads shall occur based upon either user-defined interval, manual command, or when the trend buffers become full. All trend data shall be available in disk file format compatible with third party personal computer applications.

I. Runtime Totalization

1. The FMS controllers shall automatically accumulate and store runtime hours for binary input and output points as specified in the Execution portion of this Specification.

2. The totalization routine shall have a sampling resolution of one (1) minute or less.

3. The user shall have the ability to define a warning limit for runtime totalization. Unique, user-specified messages shall be generated when the limit is reached.

4. The FMS controllers shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.

J. Event Totalization

1. Standalone FMS controllers shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.

2. The event totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.

3. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

2.4 APPLICATION SPECIFIC CONTROLLERS

A. Each FMS controller shall be able to extend its performance and capacity through the use of remote Application Specific Controllers (ASC). The ASC shall be selected to match the function required. In no case shall multiple ASCs be used for one piece of mechanical hardware or an entire system (HW or CW system) in an effort to increase point or memory capacity. If one ASC is unable perform all aspects of monitoring or control for any given piece of equipment or system, a FMS controller or more applicable ASC shall be applied.

B. Each ASC shall operate as a standalone controller on a sub-LAN and shall be capable of performing its specified control responsibilities independently of other controllers on the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor.

C. Each ASC shall have sufficient memory to support its own operating system and data bases for control routines, energy management applications, and operator I/O points.

D. The operator interface to any ASC point data or programs shall be through an operator workstation or from a portable operators terminal.

E. Power failure protection for all system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller.

F. All ASC controllers shall be fully compliant with ANSI/ASHRAE Standard 135-2012 BACnet and all published addenda at the time of installation.

2.5 TERMINAL UNIT CONTROLLER

A. A Terminal Unit Controller (TUC) shall be provided for each terminal unit as indicated on the Drawings and as listed in the equipment schedule. The TUCs shall be connected as part of a LAN or sub-LAN which shall communicate at not less than 9600 Baud. Each terminal unit controller shall communicate on a peer-to-peer basis with all units having equal authority. Provide a TUC space temperature sensor for each TUC.

B. Each TUC shall execute application programs, calculations, and commands via a microcomputer resident on the TUC. The database and all application programs for each TUC shall be stored in readable/writeable non-volatile memory within the TUC.

C. Each TUC shall contain both software and hardware to perform full DDC/PID control loops. TUCs shall be able to provide analog output, in addition to normal binary type output.

D. Each TUC shall be able to support various types of zone temperature sensors, including temperature sensor only, temperature sensor with built-in local override switch, with setpoint adjustment switch.

E. Each TUC for VAV application shall have built-in air flow transducers for accurate airflow measurement of discharge air flow in order to provide the pressure independent VAV operation.

F. Each TUC shall have a built-in detection circuit to monitor the presence of the power to the equipment, and in case of the absence of the power it shall generate on alarm to the Operator Workstation.

G. Each TUC shall have LED indication for visual status of communication, power, and all outputs. All circuits shall be optically isolated.

H. All TUC controllers shall be fully compliant with ANSI/ASHRAE Standard 135-2012 BACnet and all published addenda at the time of installation.

2.6 OPERATOR INTERFACE PANELS

A. The operator interface panel shall be a permanently mounted LCD display with keypad or touchscreen system. The LCD shall have a minimum of 80 characters on multiple lines. The operator interface panel shall connect directly to the FMS controller LAN or controller. Portable handheld devices shall not be approved.

B. The operator interface shall allow the operator to perform commands within any FMS controller on the FMS local area network including, but not limited to, the following:

- Startup or shutdown selected equipment.
- Adjust setpoints.
- Add/modify/delete schedules.
- Enable/disable process execution.
- Acknowledge alarms.
- Enable/disable totalization for each point.
- Enter temporary override schedules.
- Define holiday schedules.

- Change time/date.
- Enter/modify analog alarm limits.
- Enter/modify analog warning limits.
- View limits.
- Change password protection.

2.7 NETWORKING/COMMUNICATIONS

A. Primary Local Area Network (LAN)

1. The only FMS equipment connections to the primary LAN are the FMS controllers or routers and the operator workstations. All other FMS hardware shall reside on either the Controller LAN or the sub-controller LAN.

2. All FMS devices that reside on the primary LAN shall be compatible with the ETHERNET®.

B. FMS Controller Network (LAN)

1. FMS controllers (if not on the primary LAN) and application specific controllers Interfaces within a specific building shall reside on the second tier LAN referred to as the controller LAN. The controller LAN shall begin at the building FMS controller or router and extend to one or more FMS controller LAN controllers located throughout the building.

2. Access to system data shall not be restricted by the hardware configuration of the network. The hardware configuration of the network shall be transparent to the user when accessing data or developing control programs.

3. Expansion of the network shall support any combination of FMS controllers.

4. The network shall include provisions for automatically re-configuring itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures. The local area network shall also provide for error detection, correction, and re-transmission to guarantee data integrity.

5. Communications must be of a deterministic nature to assure calculable performance under worst-case network loading at speeds no less than 9600 bps. No collision-based network shall be accepted below 10 Mbps.

6. Automatic synchronization of the real-time clocks in all FMS controllers shall be provided.

7. Development of the controller LAN is work provided entirely under this Section of the Specification.

C. Sub-Controller Local Area Network

1. All lower level controllers associated with terminal unit controllers shall reside on the third tier LAN referred to as the sub-controller LAN.

2. The sub-controller LAN shall operate RS-485 at a selectable speed of 9.6K or higher. Development of the sub-controller LAN is work provided entirely under this Section of the Specification.

D. All products shall be new and of the latest manufacturer's design. Warranty of all products shall start on the date of final acceptance of the work.

E. All products shall be provided complete with all mounting hardware, brackets, and miscellaneous accessories whether stated in the individual product specification or not. Specific product options that are required to meet all design requirements indicated on the Drawings, stated in the sequence of operation, shown on the electrical ladder diagrams, and elsewhere in the contract documents shall be specified when the product is ordered and indicated on the catalog data sheet provided with the submittal.

2.8 DUCT STATIC PRESSURE STATION

A. Provide at each duct static pressure measuring location a traverse probe capable of continuous monitoring of static pressure. The probe shall contain multiple static pressure pickup points along the exterior surface of the cylindrical probe, internally connected to their respective averaging manifold. Each probe shall be extruded aluminum construction with threaded end support rod and nut, and mounting plate with gasket. Each probe shall be sized to span the entire duct and not extend past either side. The probe shall not produce a measurable pressure drop and shall produce a non-pulsating signal with an accuracy of 0.5 percent of total span. Air Monitor Model STAT-Probe/1 or equivalent.

2.9 OUTSIDE AIR STATIC PRESSURE PROBE

A. Outside air static pressure probe shall be constructed of 10 gage, anodized aluminum with a 2" diameter FPT connection. The probe shall be capable of sensing the outside atmospheric air pressure to within 2 percent of the actual value when subject to radial wind velocities up to 80 miles per hour with approach angles up to 30 degrees to the horizontal. Specification based on Air Monitor S.O.A.P.

2.10 ELECTRONIC DIFFERENTIAL PRESSURE TRANSMITTER

A. Electronic differential pressure transmitter shall be designed to measure the differential air pressure as indicated on the Drawings or as required. Pneumatic connections shall be 1/4" barbed and the enclosure shall be provided with holes for panel or field mounting. The output shall be a two wire 4-20 mA loop powered device with an input range as indicated in the Drawings but not more than twice the actual measure variable. The accuracy including linearity, hysteresis and repeatability shall be less than ±1 percent. Setra model C264 or equivalent.

2.11 ELECTRONIC TEMPERATURE ELEMENT AND TRANSMITTER

A. Zone Space Sensors

1. Each TUC or ASC controlling a single zone application shall be provided with a space temperature sensor. The space sensor shall include a thermistor packaged or RTD in the standard UC/sensor design, digital temperature display, timed override button, set point adjustment, and a maintenance communication port.

B. All Other Temperature Sensors

1. Thermistor temperature sensors connected to a TUC or an ASC shall be a Type II thermistor compatible with the attached FMS controller without the need for any signal conversion hardware. The accuracy of the thermistor shall be ±0.5 deg F over the range of the sensor. Precon ST series or equivalent.

2. RTD temperature sensors shall be 1000 ohm platinum having an accuracy of ±1 deg F over the entire range. The associated unit mounting transmitter shall generate a linear 4-20 mADC loop powered signal with a maximum input impedance of 675 ohms at 24 VDC.

3. Sensors used for mixed air application shall be 25' averaging type. The sensor span shall have a field set range of range of 32.0 deg F to 160.0 deg F.

4. All chilled water sensors and sensors placed in locations susceptible to condensation (outside or in chilled and condenser water liquid lines with the potential to drop below the ambient dew point) shall be furnished complete with a NEMA 3R enclosure for the electronics. The sensors shall have an immersion length of one half the pipe's diameter plus the length of the pipe tap. The sensors shall have a range of 10.0 deg F to +230.0 deg F. Units shall be furnished complete with a brass thermowell.

5. Duct temperature sensors for supply air temperatures and return temperature shall be a minimum of 18" in length. The sensor span shall have a range of -30.0 deg F to +160.0 deg F.

6. Sensors used for outdoor air temperature shall be provided complete with a sunshield. The sensor span shall have a range of -30.0 deg F to +140.0 deg F.

7. All immersion water, except chilled water sensors, shall have an immersion length of one half the pipe's diameter plus the length of the pipe tap. The sensors shall have a range of +10.0 deg F to +230.0 deg F. Units shall be furnished complete with a brass thermowell.

8. All temperature elements provided for space temperature measurement shall be installed in a white plastic housing.

2.12 AIR FLOW STATION AND TRANSMITTER

A. Pitot Tube Air Flow Element and Transmitter

1. Each airflow traverse probe shall contain multiple total and static pressure sensors located

along the exterior surfaces of the cylindrical probe and internally connected to their respective averaging manifolds. The flow sensors shall not protrude beyond the surface of the probes, and shall be the offset type for static pressure and the chamfered impact type for total pressure measurement. The airflow sensing probe's measurement accuracy shall not be affected by directional flow having pitch and/or yaw angles up to 30 degrees. Each airflow traverse probe shall be of extruded aluminum construction and furnished with mounting plates(s), gasket, and signal fittings suitable for HVAC duct installation.

2. Total and static pressure sensors shall be located at the centers of equal areas (for rectangular ducts) or at equal concentric area centers (for circular ducts) along the probe length.

3. Probes shall be AMCA certified and be capable of measuring the airflow rates within an accuracy of ±2 percent without the use of correction factors. The maximum allowable unrecovered pressure drop caused by the probes shall not exceed 0.025 inches WC at 2000 fpm or 0.085 inches WC at 4000 fpm. The number of probes required for each installation shall be in accordance with the manufacturer's design recommendations. The airflow traverse probes shall be Air Monitor Corporation Model VOLU-probe or equivalent.

4. Pitot tube type air flow element flow stations shall not be used if the manufacturer's recommended upstream and downstream clearances cannot be achieved in the installation. The Contractor shall use thermal anemometer air flow stations in these instances.

5. All airflow transmitters shall be capable of receiving flow signals from the airflow traverse probe and producing an output linear and scaled for air volume. The transmitter shall contain an integral multi-line digital display for use during the configuration and calibration process, and to display one transmitter output during normal operating mode. All transmitter configuration, parameter setting, zero and span calibration, plus display formatting and scaling will be performed digitally in the on-board microprocessor via input pushbuttons. The transmitter will be available in multiple natural spans covering the range of 0.05 inches WC to 25.0 inches WC with an accuracy of 0.25 percent of natural span. The transmitter shall be furnished with a transducer automatic zeroing circuit and be capable of maintaining linear output signals on applications requiring 5 to 1 velocity turndown. Transmitter shall have a NEMA 12 enclosure. This Specification applies to all airflow transmitters. Transmitter shall be Air Monitor Corporation VELTRON DPT 2500-plus or equivalent.

B. Thermal Air Flow Station

1. Each probe array shall consist of one or more multi-point measuring probes and a single microprocessor based transmitter. The transmitter shall be supplied by the same manufacturer as the measuring station or probe array.

2. Each multi-point probe shall be assembled using heavy wall anodized aluminum tubing, aluminum mounting plates, aerodynamically optimized molded sensing apertures to ensure accurate measurement in angular airflow conditions, and neoprene mounting gasket.

3. The probe array shall be connected to the transmitter using a single cable, of up to 100' in length, included with the transmitter.

4. Each stand-alone sensing point shall use an ambient temperature thermistor and an externally heated thermistor to determine the point velocity and temperature. Automatic equal area averaging of the individual point measurements shall be performed in the transmitter.

5. Each airflow sensor shall have an operating range of 5,000 FPM, with a NIST traceable accuracy of ±2% of reading for velocity measurement and 0.1°F for temperature measurement.

6. The sensor density shall comply with the manufacturer's recommendations based on the accuracy requirement and the size of duct the sensors are being installed in.

7. Individual sensors shall be fully field serviceable without need for field calibration, not requiring that the probe be returned to the Factory for repair and/or calibration.

8. Each transmitter shall be capable of averaging as many as thirty-two (32) sensors,

9. The transmitter will have a high visibility backlit LCD for display of either the averaged or individual sensor airflow and temperature measurements, in user selectable units of measure. The transmitter shall be factory configured to output duct air volume for plug and play operation.

10. All transmitter configuration, scaling, and diagnostic functions shall be performed by means of a password protected, cover mounted membrane keypad.

11. The transmitter outputs shall be dual analog (4-20mA, 0-5VDC or 0-10VDC) and BACnet MS/TP communication interface for airflow and temperature.

12. The operating temperature range of the transmitter shall be from -20° to 140°F. The transmitter shall be located where it will be sheltered from water or weather.

13. Input power to each transmitter shall be 24VAC/24VDC.

14. The transmitter shall be provided with interconnect cable for remote mounting up to 100' away.

15. When installed per the manufacturer's minimum installation requirements, the transmitter with accompanying station or probe array shall measure with an accuracy of ±2-3% of actual flow.

16. The Airflow Measuring System shall be the ELECTRA-flo Plus as manufactured by Air Monitor Corporation or equivalent.

2.13 ELECTRONIC HUMIDITY TRANSMITTER

A. The sensors shall have an accuracy better than ± 2.0 percent R.H. over the range of 10 to 90 percent R.H. with an operating temperature range of at least -20 to 60 deg C. The transmitter shall output a 4-20 mADC loop powered signal over the full range of the transmitter and the

input impedance shall not exceed 500 ohms at 20 VDC. The transmitter shall be specifically designed for use in measuring outdoor or duct humidity or indoor space applications as indicated.

1. Outdoor or duct mounted units shall be enclosed in a NEMA 4 enclosure with a black painted aluminum casing. Vaisala Model No. HMD 60 or equivalent.

2. Space transmitters shall be KELE Vaisala Model No. HMW 90 or equivalent.

2.14 CURRENT TRANSDUCERS

A. Current sensing transducers shall measure AC current of loads and shall output a 4-20 mADC signal over the measured range of 0 to 60 amps AC. Sensor shall have a minimum of 2.0 percent of full scale accuracy. Unit shall be split core design. Veris Industries Model H-921 or equivalent.

2.15 CURRENT SENSING SWITCH

A. Current sensing relays shall indicate the status of AC current of motor loads. The transistor switches shall be rated for switching controller DC current up to 0.1 amp continuously at 30 VDC. The setpoint of the contact operation shall be field adjustable from 1 to 135 amps AC. The switch shall be self powering with a switched load LED for local indication. Veris Industries Model H908 or equivalent.

2.16 AIR DIFFERENTIAL PRESSURE SWITCHES

A. Filter/Fan Status Switch

1. Air differential pressure switches shall have an adjustable setpoint of from 0.05" W.C. to 12.0" W.C. One snap acting SPDT Type C switch shall be enclosed under a NEMA 1 enclosure with a 1/2" conduit opening. Contacts shall be rated for 10 amps at 120 VAC. Cleveland AFS series or equivalent.

B. Static Pressure Safety Switch

1. Air pressure switch shall be manually reset type, designed to sense static pressure and break an electrical circuit when the setpoint is exceeded. The setpoint shall be adjustable form 0.4" to 12" W.C. Unit shall be furnished and installed with a static pressure tip. Kele & Associates Model AFS-460 or equivalent.

2.17 ELECTRIC LINE VOLTAGE THERMOSTAT

A. The thermostat shall be of the bimetallic design with a SPDT set of contacts rated for 120 VAC at 25 amps. Thermostat shall have an adjustable set point of from 50 deg F to 86 deg F with a fixed differential of 2.0 deg F. The cover shall be metal. Barber-Coleman Model No. TC-195 or equivalent.

2.18 ELECTRIC LOW LIMIT (FREEZESTAT)

A. Freezestat shall have a 20' temperature-sensitive element designed to respond to the lowest temperature to which any 1' length of the element is exposed. The unit shall have an adjustable set point from 35 deg F to 45 deg F. The electrical rating of the two SPDT contacts shall be 10.2 full load amps at 120. Unit shall be complete with an external manual reset lever. Johnson A70 series or equivalent.

2.19 CONTROL RELAYS

A. Control relay contacts shall be rated for 150% of the loading application, with self-wiping, snap-acting silver cadmium Form C contacts, enclosed in dust-proof enclosure. Relays shall be equipped with the necessary mounting base, DIN rail, labels, termination clips, etc., and a coil transient suppression devices. All relays for control by the FMS shall have 24 VAC coils. All other required relays shall have coil voltages appropriate for the installation. IDEC RH series or equivalent.

2.20 CONTROL TRANSFORMERS

A. Control transformers shall be provided where shown or where required to meet the sequence of operation. Control transformers shall be fused on both primary and secondary taps. Fusing shall not exceed 80 percent of the rated transformer output. Control transformers 100 VA and less may have internal secondary overload if desired but anything over 100 VA must be external fused. Control transformers over 100 VA supplying power to a control panel shall be located external to the control panel.

2.21 AUTOMATIC DAMPERS

A. All automatic dampers, except for mixing box dampers furnished with air handling units as specified on the Equipment Schedule, shall be furnished under this Section of the Specifications. These dampers shall be installed and mounted under Section 23 3000.

B. Dampers shall be constructed of extruded aluminum with oilite bronze or Teflon bearings and trunnions of non-corrosive materials. Each blade shall have a positive closing butyl-rubber or neoprene edge seal, and spring-loaded side seals unless otherwise noted. Dampers shall have louvers designed so that the blades are interconnected to give parallel movement. Jack shafting shall be provided for all dampers greater than 24" by 24". Ruskin CD-50 or equivalent.

C. Parallel Blade Dampers: Provide parallel blade type automatic dampers for return air dampers, two-position dampers, the face section of face and bypass dampers, and where indicated on the Drawings.

D. Opposed Blade Dampers: Provide opposed blade type dampers for volume control, exhaust and outside air dampers of a mixing section, throttling application and where indicated on Drawings.

2.22 DAMPER ACTUATORS

A. Electronic Damper Actuators

1. The actuator shall be of the direct-coupled design. The fastening clamp assembly shall be of a V-bolt design with associated V-shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a V-clamp assembly of sufficient size to be directly mounted to an integral jack shaft of up to 1.05 inches when the damper is constructed in this manner. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a two (2) year manufacturer's warranty, starting from the date of installation.

2. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable. For power-failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable.

3. Spring return actuators shall be provided for all outside and exhaust/relief air dampers in addition to all locations indicated on the Drawings. Spring return actuators shall be capable of both clockwise and counterclockwise spring return operation by simply changing the mounting orientation.

4. Proportional actuators shall accept a 0 - 10 VDC or 0 - 20 mA control input and provide a 2 - 10 VDC or 4 to 20 mA operating range. All actuators shall provide a 2 - 10 VDC position feedback signal and shall have an external, built-in switch to allow the reversing of direction of rotation.

5. All actuators shall not require more than 10 VA regardless of the operating voltage.

6. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in/lb torque capacity shall have a manual crank.

7. Actuators shall be provided with a conduit fitting and a minimum three-foot electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.

8. Actuators shall be Underwriters' Laboratories Standard 873 listed and Canadian Standards Association Class 481302 certified as meeting correct safety requirements and recognized industry standards.

9. Manufacturer shall be ISO9001 certified. Actuators shall be manufactured by BELIMO or equivalent.

2.23 CONTROL VALVES

A. Ball Control Valves Three Inches and Less.

1. Two-way control valves shall be industrial quality with bronze bodies and female NPT threads. Valve bodies may also be stainless steel, titanium or nickel with operating pressure up to 600 psi. The maximum operating differential shall be 5 psi for water. Valve bodies shall not be sized at less than 2 pipes less than the pipe it is installed in.

2. All valves shall have blowout proof stem design, glass-reinforced Teflon thrust seal washer and stuffing box ring with minimum 600 psi rating. Stem packing gland screw shall be adjustable for wear.

3. Standard chromium plated stainless steel ball and stem, shall be rated at a minimum of 600 psi WOG (water-oil-gas), cold, non-shock, and 150 psi for saturated steam service. All valves shall be provided with reinforced Teflon seats.

4. Belimo, Bray, or equivalent.

B. Two- and Three-Way Globe Control Valves Two Inches and Less.

1. Valves 1/2" through 2" shall be bronze, screw type, and shall be rated at 250 psi maximum working pressure for water and steam.

2. Valve stems shall be stainless steel, highly polished, corrosion-resistant, alloy to decrease friction and increase response. Valve plugs shall be brass and guided to ensure perfect seating.

3. Stem packing shall be spring loaded EP V-rings for water applications and Teflon V-rings for steam applications to eliminate leakage around the stem and ensure a minimum amount of stem friction. Stem lift shall be 1/2" to 3/4".

4. Flow type shall be equal percentage for water. The maximum operating differential shall be 5 psi for water.

5. Composition discs shall be replaceable and provide tight shutoff.

6. Belimo, Bray, or equivalent.

C. Two- and Three-Way Globe Control Valves Greater than Two Inches.

1. Valves 2-1/2" through 6" shall be cast iron flanged, and rated at 125 psi maximum working pressure. The maximum working temperature shall be 300 deg F/149 deg C.

2. Valve plug stems shall be stainless steel, highly polished, corrosion-resistant, alloy to decrease friction and increase response. Valve plugs shall be brass and guided to ensure perfect seating. Stem packing shall be Teflon, spring loaded EP V-rings to eliminate water leakage around the stem and ensure a minimum amount of stem friction. Lift shall be 3/4" to 1-1/2".

3. Flow type shall be equal percentage. The maximum recommended differential shall be 5 psi for water.

4. Composition discs shall be replaceable and provide tight shutoff.

5. Belimo, Bray, or equivalent.

2.24 CONTROL VALVE ACTUATORS

A. Electronic Globe and Ball Valve Actuators

1. Ball valves actuator shall be fully modulating using 2-10 VDC or 4-20 mADC, floating point, two-position spring return as indicated in the control sequence. Fail safe, where specified, shall require mechanical spring return. The actuator shall be positive positioning, responding to a 2-10 VDC or 4-20 mA signal (with the addition of a 500 ohm resistor). There shall be a visual valve position indicator. Power shall be 24 VAC unless indicated otherwise on the Drawings and shall not exceed 8 watts at 24 VAC. A 3-foot cable shall be provided for easy installation to an electrical junction box. The actuator shall provide minimum torque required for proper valve close-off, with an approximate running time of two (2) minutes for full rotation. The actuator shall be designed with current limiting motor protection. (End of travel switches and magnetic clutches are not acceptable.) A release button on the actuator shall be provided to allow for manual override, except when utilizing spring return actuators.

2. Ball Valves: All actuators shall be UL listed. The manufacturer shall warranty all the actuators and valve assemblies for a period of two (2) years from date of installation.

3. The actuators and valves shall be factory mounted and tested and supplied. Belimo, Bray, or equivalent.

2.25 ELECTRICAL CONTROL POWER AND LOW VOLTAGE WIRING

A. Provide interlock wiring between supply and exhaust fans, electrical wiring for relays (including power feed) for temperature and pressure indication. Provide interlock wiring between refrigeration machines, pumps and condensing equipment as required for the specified sequence of operation and the refrigeration system integral controller(s). Do not provide interlock wiring if a dedicated digital output has been specified for the equipment or the sequence of operation requires independent start/stop.

B. Provide power wiring, conduit and connections for low temperature thermostats, high temperature thermostats, alarms, flow switches, actuating devices for temperature, humidity, pressure and flow indication, point resets and user disconnect switches for electric heating, appliances controlled by the FMS.

C. Provide all other wiring required for the complete operation of the specified systems including control power wiring not expressly stated to be provided by Division 26.

D. Install all wiring raceway systems complying with the requirements of the National Electrical Code and Division 26. All installations shall be installed in EMT.

E. FMS Network Communication Requirements

1. Wired network communication shall be via channels consisting of communications wire installed in a 3/4" EMT or of communications cable installed in the ceiling as outlined in other parts of this specification.

2. Telephone lines, where required as a remote communication source, shall utilize voice band, non-switched, private line channels consistent with Bell Systems Technical Reference Publication 41001 and shall be four-wire unconditioned 3002 channels. The modems shall have 25 pin EIA connectors and RS-232C interface.

3. Communication conduits and wiring shall not be installed closer than six feet from high power transformers or run parallel within six feet of electrical high power cables. Care shall be taken to route the cable as far from interference generating devices as possible.

4. All shields shall be ground (earth ground) at one point only, to eliminate ground loops.

5. There shall be no power wiring, in excess of 30 VAC rms, run in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, all communication wiring and signal wiring shall be run using separate twisted shielded pairs (24 AWG) with the shields grounded in accordance with the manufacturer's wiring practices.

F. Power and Communication Wiring Transient Protection

1. The control manufacturers shall submit catalog data sheets providing evidence that all FMS products offered by the manufacturer are tested and comply with the standard for Transient Surge withstand capabilities for electrical devices ANSI C62.41, IEEE-587-1980, Categories A and B. Such testing shall have included power and communication trunk wiring. Compliance with IEEE-587 shall imply conformance with IEEE-472 transient standards based on the stated position of ANSI and IEEE regarding applicability of the rated standards.

2. Communications trunk wiring shall be protected with a transient surge protection device providing the minimal protection specifications of the General Semiconductor, Model #422E device.

3. The communications circuitry, input/output circuitry, and CUs, shall provide protection against a 1000 volt, 3 amp transient signal, directly applied to the communication or input/output terminations. The manufacturer’s catalog data sheet shall provide evidence of conformance with this requirement. Systems not complying with this requirement shall provide equivalent protection external to the FMS controller. Protection shall be provided for the individual communications and input/output terminations for each FMS controller. Submittal documentation shall clearly define how this requirement will be met and how the external protection will not affect the performance of the controllers.

G. Input/Output Control Wiring

1. RTD wiring shall be three-wire or four-wire twisted, shielded, minimum number 22 gage.

2. Other analog inputs shall be a minimum of number 22 gage, twisted, shielded.

3. Binary control function wiring shall be a minimum of number 18 gage.

4. Analog output control functions shall be a minimum of number 22 gage, twisted, shielded.

5. Binary input wiring shall be a minimum of number 22 gage.

6. Thermistors shall be equipped with the manufacturer's calibrated lead wiring.

7. 120V control wiring shall be #14 THHN in 3/4" conduit. Provide 4 or 20 percent fill extra wire in each conduit.

H. Splices

1. Splices in shielded cables shall consist of terminations and the use of shielded cable couplers which maintain the integrity of the shielding. Terminations shall be in accessible locations. Cables shall be harnessed with cable ties as specified herein.

I. Conduit and Fittings

1. Conduit for Control Wiring, Control Cable and Transmission Cable: Electrical metallic tubing (EMT) with compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections.

2. Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.

3. Outlet Boxes (Exposed to Weather): Threaded hub cast aluminum or iron boxes with gasket device plate.

4. Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.

2.26 AIR PIPING

A. Hard tubing shall be copper connected with sweat or compression fittings.

B. Plastic tubing shall be specifically designed for use with control systems. The tubing shall be resistant to ultraviolet breakdown, stress cracking and shall meet all requirements for fire retardant smoke propagation as required by applicable codes and regulations.

C. Tubing run in walls from thermostats to equipment above the ceiling shall meet the Specifications of plastic tubing stated previously but shall have an additional armored jacket to prevent chafing on stud and plated penetrations.

2.27 SMOKE AND FIRE DETECTORS

A. Smoke detectors shall be supplied, powered, installed, and interlocked in accordance with Section 23 0549. The smoke detectors shall be listed by Underwriters' Laboratories, Inc. The units shall be designed for detection of combustion gases, fire and smoke in air conditioning and ventilation system ducts, in compliance with the National Fire Protection Association,

Recommended Practices Pamphlet No. 90A. It shall consist of an ionization type detector with self-contained control unit. The assembly shall consist of a casting to accommodate metallic sampling tubes which extend across the duct of the ventilation system.

B. The unit shall provide two (2) sets of normally open single pole, double throw alarm operated relay contacts (5A, 120V, AC).

C. The unit shall be bolted directly to the duct or plenum wall. A template shall be provided for making necessary cutouts and holes. Complete instructions shall be provided with units.

D. Unit shall be capable of stable operation from 0 deg to 150 deg F.

E. Sampling tubes shall be EMT tubing, 1/2-inch in diameter, length and support as required to extend across plenum or duct. Quantity and location of sampling tubes shall be as required for representative sampling. Plastic tubes will not be allowed.

2.28 TEMPERATURE CONTROL PANELS

A. Control panels shall be provided as required for mounting of system control devices as indicated on the Drawings. Panel shall be sized as required to accommodate controls with hinged door, key lock. Panel shall be constructed of metal with metal mounting backplanes. All panels shall be supplied with the same key. All panels shall be NEMA rated and UL listed. Hoffman or equivalent.

2.29 CARBON DIOXIDE SENSOR

A. The carbon dioxide sensor shall be specifically designed to generate a linear 0-10 VDC or 4-20mA signal proportional to a 0-2000ppm CO2 level in the duct. The unit shall have an accuracy of +/-2% of full scale up to 1400ppm and a selectable auto-calibration mode. Sensor shall have a minimum of 5 year warranty. SENVA Sensors C02D or equivalent.

2.30 EQUIPMENT CONNECTIONS

A. Not Applicable.

2.31 ELECTRONIC LIQUID DIFFERENTIAL PRESSURE SENSOR

A. Electronic differential pressure transmitter shall be designed to measure the differential liquid pressure as indicated on the Drawings or as required. Liquid connection shall be 1/4" NPT and the enclosure shall be NEMA 4 with 1/2" conduit knockouts. The output shall be a two wire 4-20 mA loop powered device with an input range has indicated in the Drawings but not more than twice the actual measure variable. The accuracy including linearity, hysteresis and repeatability shall be less than or equal to ± 0.25% of full scale. Setra Model C230 or equivalent.

2.32 ELECTRONIC LIQUID PRESSURE SENSOR

A. Electronic pressure transmitter shall be designed to measure the liquid gauge pressure as indicated on the Drawings or as required. Liquid connection shall be 1/8" NPT. The unit shall have an accuracy of ± 0.13% of full scale. The unit shall have stainless steel media. Setra Model C206 or equivalent.

2.33 INDOOR STATIC AIR PROBE

A. Indoor static air probes shall be provided for each indoor air pressure measurement location. They shall be flush mounted with a concealed connection. They shall be constructed of 10 gage aluminum with a 1/8" coupling for output signal connection. Air Monitor S.A.P. or equivalent.

2.34 BOILER REMOTE SHUTDOWN SWITCH

A. The emergency shutdown switch or circuit breaker must be sufficient to disconnect all power to the burner controls. It shall be constructed in a manner that safeguards it against tampering. The switch and installation shall comply with the National Electric Code, NFPA No. 70 and ASME CSD-1 CE-110.

2.35 ELECTRONIC HVAC LIQUID FLOWMETER

A. Insertion Electromagnetic Type

1. The flowmeter shall be of the insertion electromagnetic type which penetrates into the line. The flowmeter shall be furnished complete with a flow transmitter which supplies a 4-20 mA or 0-10 VDC signal for flow. Meter shall have an accuracy of no less than 1% of the actual reading over the range of the meter. Meter shall include all necessary equipment to allow the flow meter to be inserted or removed without draining the system. Flow meter shall be installed within the manufacturer's required straight pipe lengths for accuracy. If the location of the insertion meter cannot meet these requirements, then the Inline Electromagnetic Type meter shall be used. Flow meter shall be Onicon F-3500 or equivalent.

B. Inline Electromagnetic Type

1. The flowmeter shall be of the inline electromagnetic type which installs into the line. The flowmeter shall be furnished complete with a flow transmitter which supplies a 4-20 mA or 0-10 VDC signal for flow and remote digital display. Meter shall have an accuracy of no less than 1% of the actual reading over the range of the meter. Meter shall be 24 VAC powered. Meter shall include all necessary gaskets required for installation into the system. Flow meter shall be installed within the manufacturer's required straight pipe lengths for accuracy. Flow meter shall be Onicon F-3200 or equivalent.

2.36 DOMESTIC WATER SUB-METER

A. The flowmeter shall be of the inline electromagnetic type which installs into the line. The flowmeter shall be furnished complete with a flow transmitter which supplies a 4-20 mA or 0-10 VDC signal for flow and remote digital display. Remote display shall have

Modbus RTU communication connection. Meter shall have an accuracy of no less than 1% of the actual reading over the range of the meter. Meter shall be 24 VAC powered. Meter shall be Meter shall include all necessary gaskets required for installation into the system. Flow meter shall be installed within the manufacturer's required straight pipe lengths for accuracy. Flow meter shall be Onicon F-3100 or equivalent.

2.37 GAS SUB-METER

A. The flow meter shall be hand-insertable up to 250 psi. Materials of construction for wetted metal components shall be 316 SS. The flow meter shall provide SFPM flow readings from a pair of encapsulated platinum sensors and shall not require additional temperature or pressure compensation. In addition, the meter shall continuously display information that can be used to validate the calibration of the meter. Each flow meter shall be individually wet-calibrated against a standard that is directly traceable to NIST*. A certificate of calibration shall be provided with each flow meter. Provide flow meter assembly complete with all installation hardware necessary to enable insertion and removal of the meter without system shutdown.

B. Accuracy shall be within ± 1% of rate from 500-7000 SFPM and ± 2% of rate from 100-500 SFPM. Overall turndown shall exceed 1000:1. Output signals shall consist of the following: (1) analog 4-20mA output and (1) scalable pulse output for totalization. The meter shall be equipped with an integrally mounted graphical display that may be optionally remote mounted up to 1000 ft from the sensor. Each flow meter shall be covered by the manufacturer's two-year warranty. Meter shall have Modbus RTU communications connection. Provide an ONICON Model F- 5200 Insertion Thermal Mass Flow Meter. Meter shall be rated for outdoor application.

2.38 MEASUREMENT AND VERIFICATION SYSTEM

A. The contractor shall provide a new Measurement &Verification (M&V) monitoring system which is in accordance with PSFA requirements. The system shall consist of electric meters, gas meter, and domestic water meter which connect to a FieldServer which will transfer this information to an offsite central server.

B. Furnish and install obvius AcquiSuite EBM A8810 communications module.

2.39 MEASUREMENT AND VERIFICATION POWER METERS

A. The meter shall be UL listed and CE marked.

B. The meter shall be designed for Multifunction Electrical Measurement on 3 phase power systems. The meter shall perform to spec in harsh electrical applications in high and low voltage power systems.

1. The meter shall support 3 Element Wye, 2.5 Element Wye, 2 Element Delta, 4 wire Delta systems.

2. The meter shall accept universal voltage input.

3. The meter's surge withstand shall conform to IEEE C37.90.1.

4. The meter shall be user programmable for voltage range to any PT ratio.

5. The meter shall accept a burden up to 0.36VA per phase, Max at 600 V, and 0.014 VA at 120 Volts.

6. The meter shall accept a voltage input range of up to 576 Volts Line to Neutral, and up to 721 Volts Line to Line.

7. The meter shall accept a current reading of up to 11 Amps continuous.

8. The meter shall have color-coordinated voltage and current inputs.

9. The meter shall have a phasor diagram, through software, that clearly shows wiring status.

C. The meter shall use a dual input method for current inputs. Method one shall allow the CT to pass directly through the meter without any physical termination on the meter. The second method shall provide additional termination pass through bars, allowing the CT leads to be terminated on the meter. The meter must support both termination methods.

1. Fault Current Withstand shall be 100 Amps for 10 seconds, 300 Amps for 3 seconds, and 500 Amps for 1 second.

2. The meter shall be programmable for current to any CT ratio. DIP switches or other fixed ratios shall not be acceptable.

3. The meter shall accept a burden of 0.005 VA per phase, Max at 11 Amps.

4. The meter shall begin reading at 0.1% of the nominal current.

5. Pass through wire gauge dimension of 0.177" / 4.5 mm shall be available.

6. All inputs and outputs shall be galvanically isolated to 2500 Volts AC.

7. The meter shall accept current inputs of class 10: (0 to 10) A, 5 Amp Nominal, and class 2 (0 to 2) A, 1 Amp Nominal Secondary.

D. Multifunction, Data-Logging, Power and Energy Meter with Advanced I/O and Power Quality

1. The meter shall have an accuracy of +/- 0.1% or better for Volts and Amps, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC62053-22 (Class 0.2%) and ANSI C12.20 (Class 0.2%). The meter shall have a Frequency measurement accuracy of not less than 0.001 Hz.

   a. The meter shall provide true RMS measurements of voltage, - phase to neutral and phase- to-phase; and current, per phase and neutral.

   b. The meter shall calculate RMS readings, sampling at over 400 samples per cycle on all channels measured readings continuously with no cycle blind spots.

   c. The meter shall utilize 24 bit Analog to Digital conversion.

d. The meter shall provide %THD (% of Total Harmonic Distortion). Harmonic magnitude recording to the 40th order shall be available for voltage and current harmonics.

2. The meter shall provide a simultaneous voltage and current waveform recorder.

   a. The meter shall be capable of recording 512 samples per cycle for a voltage or swell, or for a current fault event.

   b. The meter shall provide pre- and post-event recording capability.

   c. The meter shall have a programmable sampling rate for the waveform recorder.

   d. The meter shall have an advanced DSP design that allows power quality triggers to be based on a 1 cycle updated RMS.

   e. The meter shall allow up to 170 events to be recorded.

   f. The meter shall store waveform data in a first-in, first-out circular buffer to insure that data is always being recorded.

3. The meter shall include a three-line, bright red, .56" LED display.

   a. The meter shall fit in both DIN 92 mm and ANSI C39.1 round cut-outs.

   b. The meter must display a % of Load Bar on the front panel to provide an analog feel. The % Load bar shall have not less than 10 segments.

4. The meter shall be available in transducer only version, with no display.

   a. The meter shall mount directly to a DIN rail and provide RS485 Modbus or DNP 3.0 output.

5. The meter shall be a traceable revenue meter, which shall contain a utility grade test pulse allowing power providers to verify and confirm that the meter is performing to its rated accuracy.

6. Power meter shall include virtual measurement upgrade packs (V-Switch™ keys), which shall allow user to upgrade in field without removing installed meter.

   a. The six Virtual Upgrade packs shall be:

      Volts, Amps, kW, kVAR, PF, kVA, Freq., kWh, kVAh, kVARh, and I/O Expansion - V1 Above with 2 Megabytes of memory for Data-logging - V2

      Above with Power Quality Harmonics - V3 Above,
      with Limit and Control Functions - V4

      Above, with 64 samples per cycle Waveform Recorder and 3 Megabytes of memory for Data-logging - V5

      Above, with 512 samples per cycle Waveform Recorder and 4 Megabytes of memory for Data-logging - V6

   b. The V-Switch™ keys must be able to be implemented without physically removing the installed meter.

7. The meter shall include 2 independent communications ports on the back and face plate, with advanced features.

    a. One port shall provide RS485 communication speaking Modbus ASCII, Modbus RTU, or DNP 3.0 protocol through back plate.

    b. Baud rates shall be from 1200 baud to 57600 baud for the RS485 port.

    c. The meter shall provide an optical IrDA port (through faceplate), as the second communication port, which shall allow the unit to be set up and programmed using a PDA or remote laptop without need for a communication cable.

8. The meter shall provide user configured fixed window or rolling window demand. This shall allow the user to set up the particular utility demand profile.

    a. Readings for kW, kVAR, kVA and PF shall be calculated using utility demand features.

    b. All other parameters shall offer max and min capability over the user selectable averaging period.

    c. Voltage shall provide an instantaneous max and min reading displaying the highest surge and lowest sag seen by the meter.

    d. The meter shall provide an update rate of every 6 cycles for Watts, VAR and VA. All other parameters shall be every 60 cycles.

9. The meter shall support a power supply of 90 to 265 Volts AC and 100 to 370 Volts DC. Universal AC/DC Supply shall be available and shall have a burden of less than 11 VA. An optional power supply of 18-60 Volts DC shall be available.

10. The meter shall provide Limits Alarms and Control Capability as follows:

    a. Limits can be set for any measured parameter.

    b. Up to 16 limits can be set.

    c. Limits shall be based on % of Full Scale settings.

    d. Manual Relay Control shall be available through software.

    e. Relay set delays and reset delays shall be available.

    f. Relay control shall be available through DNP over Ethernet with the Ethernet Option card.

11. The meter shall have data logging capability with the 2, 3, and 4 Megabyte memory upgrade (Virtual Upgrade packs 2-6). The meter shall have a real-time clock that allows for time stamping of all the data in the meter when log events are created. The meter with Virtual Upgrade packs 2-4 shall have six logs; the meter with Virtual Upgrade packs 5 and 6 shall also have the Waveform Log:

    a. The meter shall have three historical logs for trending profiles. Each log shall be capable of being programmed with up to 64 parameters. The user shall have the ability to allocate memory between the three historical logs in order to increase or decrease the memory allotted to each of the logs.

    b. The meter shall have a log for Limits Alarms. The Limits log shall provide magnitude and duration of an event, time-stamp, and log value. The log must be

capable of recording to 2048 events.

c. The meter shall have a log for System Events. The System Events log shall record the following occurrences with a time-stamp: Demand Resets, Password Requests, System Startup, Energy Resets, Log Resets, Log Reads, Programmable Settings Changes, and Critical Data Repairs.

d. The meter shall have a log for I/O changes. The I/O Change log shall provide a time-stamped record of any Relay Outputs and any Input Status changes. The log must be capable of recording up to 2048 events.

e. The meter with Virtual Upgrade packs 5 and 6 shall have a log which is capable of recording a waveform both when a user-programmed value goes out of limit and when the value returns to within limit.

f. The meter shall have I/O expandability through two Option card slots on the back.

g. The cards shall be capable of being installed in the field, without removing the meter from installation.

h. The meter shall auto-detect the presence of any I/O Option cards.

i. The Option card slots shall accept I/O cards in all of the following formats: 100BaseT Ethernet Communication Card; Four Channel Bi-directional 0-1mA Output Card; Four Channel 4-20mA Output Card; Two Relay Outputs/2 Status Inputs Card; Four Pulse Output/4 Status Inputs Card; Fiber Optic Card; IEC 61850 Protocol Ethernet Network Card.

j. The meter shall be capable of accepting any combination of up to two cards.

k. When two Ethernet cards are installed in the meter, an independent IP address and MAC address shall be assignable to each card.

l. The Ethernet Option Card shall provide the meter with 100BaseT Ethernet functionality. The Ethernet Option card shall:

    1) Allow the meter to speak with 12 simultaneous sockets of Modbus TCP, so that multiple requests for data can be received simultaneously.

    2) Allow the meter to speak with 5 simultaneous sockets of DNP over TCP/IP so that multiple requests can be handled simultaneously.

    3) Allow the meter to speak with both Modbus TCP and DNP over Ethernet simultaneously. Allow auto transmit/receive detection for straight or null RJ45 cables.

m. Provide an embedded Web server that allows access to metered readings through the Internet, using any standard Web browser from a PC, smart phone, or tablet PC.

n. Provide email on configured alarms.

o. Provide email notification of meter status and readings data on a programmed schedule.

p. The 1mAO Option Card shall provide the following features: 4 channel, bi-directional 0-1mA outputs.

q. Assignable to any measured parameter.

    1) 0.1% of Full Scale accuracy throughout range and load. Maximum load

impedance to 10k Ohms, with no accuracy losses.

r. The 20mAO Option Card shall provide the following features: 4 channel, 4-20mA outputs.

s. Assignable to any measured parameter.

1) 0.1% of Full Scale accuracy throughout range and load. Maximum load impedance to 850 Ohms, with no accuracy losses. Loop powered using up to 24 Volts DC.

t. The Relay Output/Status Input Option Card shall provide the following features: 2 Relay outputs, 2 Status inputs.

u. Status Inputs – Wet/Dry Auto Detect up to 150 Volts DC.

v. Trigger on User Set Limits/Alarms (with Virtual Upgrade pack 4). Set delays and Reset delays.

w. The Pulse Output/Digital Input Option Card shall provide the following features: 4 KYZ pulse/4 Status inputs.

x. Programmable to any energy parameter and pulse value. Programmable to End of Interval pulse.

y. Can function for manual relay control and limit based control (with Virtual Upgrade pack 4).

z. 120mA continuous load current. DNP input.

aa. The Fiber Optic Option Card shall provide the following features:

1) Built in logic to mimic RS485 half-duplex bus, allowing the user to daisy chain meters for low installation cost.

2) ST Terminated Option.

3) Versatile Link Terminated Option. Modbus and DNP 3.0 protocols available.

bb. The IEC 61850 Protocol Ethernet Network Option Card shall provide the following features:

1) Integrates into any IEC 61850 network.

2) Provides support for Modbus and IEC 61850 protocols simultaneously. Configurable for multiple logical nodes.

3) Provides buffered and unbuffered reporting.

4) Provides dual Ethernet IEC 61850 Protocol Network option cards. Is certified by a 3rd party Authorized IEC61850 Test Laboratory.

cc. Is capable of supporting two Ethernet /IP connections with separate /IP addresses, each running IEC 61850 protocol.

12. The meter shall have transformer loss, line loss, and total substation loss compensation.

a. Substation losses shall be programmable for Watts and VARs, and for Ferris and copper losses.

b. The meter shall have CT and PT compensation to set compensation factors for errors in CTs and PTs connected to the meter.

13. The meter shall have a standard 4-year warranty.

14. Power meter shall be able to be stored in (-20 to +70) degrees C.

    a. Operating temperature shall be (-20 to +70) degrees C.

    b. NEMA 1 faceplate rating shall be available for the power meter.

15. Acceptable product is Electro Industries/GaugeTech, Model: Shark®200-60-10-V5-D2-INP100S- X.

E. Multifunction Power and Energy Meter

1. The meter shall have an accuracy of +/- 0.1% or better for volts and amps, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC687 (class 0.2%) and ANSI C12.201(Class 0.2%).

    a. The meter shall provide true RMS measurements of voltage, phase to neutral and phase to phase; current, per phase and neutral.

    b. The meter shall provide sampling at 400+ samples per cycle on all channels measured readings simultaneously.

    c. The meter shall utilize 24 bit Analog to Digital conversion.

    d. Meter shall provide Harmonics %THD (% of total Harmonic Distortion).

2. The meter shall include a three line, bright red, .56" LED display.

    a. The meter shall fit in both DIN 92mm and ANSI C39.1 Round cut-outs.

    b. The meter must display a % of Load Bar on the front panel to provide an analog feel. The % Load bar shall have not less than 10 segments.

3. Meter shall be available in transducer only version, which shall not include a display.

    a. The meter shall mount directly to a DIN rail and provide RS485 Modbus or DNP 3.0 output.

4. The meter shall be a traceable revenue meter, which shall contain a utility grade test pulse allowing power providers to verify and confirm that the meter is performing to its rated accuracy

5. Power meter shall include virtual measurement upgrade packs, which shall allow user to upgrade in field without removing installed meter.

    a. Four upgrade packs shall be:

        1) Volts and Amps Meter – Default

        2) Volts, Amps, kW, kVAR, PF, kVA, Freq.

        3) Volts, Amps, kw, kVAR, PF, kVA, Freq., kWh, kVAh, kVARh.

        4) Volts, Amps, kW, kVAR, PF, kVA, Freq., kWh, kVAh, kVARh, %THD Monitoring and Limit Exceeded Alarms.

    b. These virtual upgrade packs must be able to be updated without physically removing the installed meter.

c. Meter shall be a traceable revenue meter, which shall contain a utility grade test pulse allowing power providers to verify and confirm that the meter is performing to its rated accuracy.

6. The meter shall include 2 independent communications ports on the back and face plate, with advanced features.

   a. One port shall provide RS485 communication speaking Modbus ASCII, Modbus RTU, or DNP 3.0 protocol through back plate.

   b. Baud rates shall be from 9,600 baud to 57,600 baud.

   c. The meter shall provide an optical IrDA port (through faceplate), as the second communication port, which shall allow the unit to be set up and programmed using a remote laptop PC without need for a communication cable.

   d. Meter shall have 8 Bit, No parity.

7. The meter shall have optional 100BaseT Ethernet communication capability.

   a. Ethernet communication shall consist of Modbus protocol over TCP/IP.

8. The meter shall provide user configured fixed window or rolling window demand. This shall allow user to set up the particular utility demand profile.

   a. Readings for kW, kVAR, kVA and PF shall be calculated using utility demand features.

   b. All other parameters shall offer max and min capability over the user selectable averaging period.

   c. Voltage shall provide an instantaneous max and min reading displaying the highest surge and lowest sag seen by the meter.

9. The meter shall support power supply of 90 to 265 Volts AC and 100 to 370 Volts DC. Universal AC/DC Supply shall be available.

   a. Meter power supply shall accept burden of 10VA max.

   b. Meter shall provide upgrade rate of 100msec for Watts, Var and VA. All other parameters shall be 1 second.

10. The meter shall have a standard 4-year warranty.

11. Power meter shall be able to be stored in (-20 to +70) degrees C.

    a. Operating temperature shall be (-20 to +70) degrees C.

    b. NEMA 12 faceplate rating shall be available for the power meter.

12. Acceptable product is Electro Industries/GaugeTech, Model: Shark 200

PART 3 - EXECUTION

3.1 GENERAL

A. All devices, conduit, wiring, etc., shall be installed in a neat professional manner by skilled persons.

1. The installation of all aspects of the system shall comply with all applicable codes and regulations and with Division 26 Specifications.

2. The installation of all materials shall be in accordance with the published manufacturer's recommendations without exception. If for some reason a particular component cannot be installed in compliance with these recommendations, the Contractor shall advise the Engineer of the situation.

3. Where miscellaneous materials are required to complete an installation, i.e., isolation valves for pressure switches, wall switches for an exhaust fan control circuit, etc.; the materials shall be supplied as defined in the relevant Section of these Specifications. For example, Section 23 0523 specifies valve requirements, and Division 26 specifies electrical products and requirements.

4. Coordinate with other trades where installation of a particular component requires other trades to be involved. Installation coordination includes location the correct placement of thermowells, flow switches, dampers, control valves, control power circuits, etc. Care must be exercised to identify locations that meet the requirements of the manufacturer including upstream and downstream distances, pressures, temperatures, etc.

5. Review the contract documents prior to installation. If the drawings show any instrumentation to be installed in a location where the system would not function properly (e.g., a temperature transmitter or thermostat located in a space not served by the terminal unit that transmitter controls) then submit an RFI with a sketch showing where the Contractor recommends the instrument be installed. Do not install instrumentation in locations where the system will not function properly.

6. All field devices shall be labeled with 1" x 3" phenolic labels. Labels shall include the point name and device name. Labels for EMS controllers shall indicate the breaker and panel number of the power source. Labels shall be glued, attached with screws, or copper wire in the case of valves and actuators.

7. On each terminal unit and fan control unit provide an adhesive film label showing the unit identification of the device as it appears on the construction drawings. The label shall be approximately three inches high by five inches wide, with the identification characters approximately one inch high. The characters shall be printed in black on an orange background. The label shall be placed on the unit at a location easily observable by maintenance personnel.

3.2 PRIMARY OPERATORS STATIONS

A. The existing primary operator workstation shall be used for this project. All of the software development specified in this paragraph shall be implemented/upgraded on the workstation server.

B. User Access

1. The Owner shall be interviewed and all desired passwords and password levels shall be installed at all workstations.

C. Reports

1. The Owner shall be interviewed and all reports desired shall be completely configured including correct formatting, delivery frequency, etc.

D. Dynamic Color Graphic Displays

1. All color graphic slides shall be developed to the satisfaction of the Owner. The slides shall include all realtime point assignments, user interactive points, and realtime alarm information. At a minimum, the following graphic slides shall be developed:

   a. One site map shall be provided which allows the operator to connect to any or building available to the operator. This area map shall include all buildings connected to the system. This graphics shall visually reflect the architectural features of the appropriate building. Global point information including OSA temperature and humidity, current demand level, and building outside air dry bulb and dew point temperatures shall be displayed on this graphic as applicable to the job. A "pick" shall be provided for the operator to move to any specific building.

   b. A graphic shall be provided for each building floor plan. All temperature zones within the floor plan shall be reflected and the actual temperatures within the zones shall be displayed. This graphic shall be color coded to reflect green if a particular temperature zone on the floor plan is at the setpoint temperature, blue if a particular temperature zone on the floor plan is below the setpoint temperature, and red if a particular temperature zone on the floor plan is above the setpoint temperatures. "Pick" windows shall be provided on these graphics to permit the operator to view specific temperature zone graphics relative to the respective floor plan.

   c. A graphic shall be provided for each temperature zone of each floor. This graphic shall be a "Zoom" view of the selected temperature zone of the respective floor plan. All information displayed on the building floor plan relative to any particular temperature zone and all color coding of the temperature zone shall be the same as was provided for the floor plan graphics. "Pick" windows shall be provide on these graphics to permit the operator to view specific mechanical system graphics relative to the respective floor plan.

   d. Separate graphics shall be provided for all mechanical equipment serving the respective building or zone. This includes all central station units, boiler plant, air compressors, central plant, etc. Mechanical system graphics shall be displayed complete with all real time data relevant to the equipment being displayed including temperatures, flow rates, positions, etc.

2. Database Save/Restore/Backup

   a. After all FMS controller software, operator workstation software, and graphic slides have been developed, two (2) complete backup sets of this software shall be delivered to the Architect for archiving.

3.3 FMS CONTROLLERS

A. General

1. All FMS controllers shall be installed in accordance with manufacturer's instructions. Power shall be provided to each FMS controller in accordance with Division 26 and all applicable codes.

2. All FMS controllers shall be installed in an enclosure that provides protection from the environment and is adequately ventilated to protect against excessive temperature exposure.

B. Input/Output

1. All points shown on the control diagrams or required to meet the Sequence of Operation shall be connected to the respective FMS controller in accordance with the manufacturer's instructions. Each point shall be checked for voltage, short circuit, etc., prior to termination to the FMS controller to prevent potential damage to the controller.

C. Software Requirements

1. General

a. All sequences of operation listed on the Drawings are to be implemented as they relate to the points shown on the Drawings. Any additional points required to meet the sequence of operation shall be provided whether indicated on the Drawings or not. In addition to the sequences of operation indicated on the Drawings, the following general sequences shall be implemented.

2. Optimal Start

a. Develop software to start all equipment based on the individual zone temperature, outside air temperature, heating/cooling capacity in degree Fahrenheit/hour of the equipment serving that zone and the previous optimal start time in establishing the optimal start time for the following day. The optimal start program shall work in conjunction with the scheduled start time to minimize energy consumption.

b. In no case shall the optimal start routine keep the AHU from running after the occupancy start time identified as the scheduled start time.

c. The AHUs shall run continuously until the scheduled stop time. No optimal stop program time shall be provided.

3. Run Time Totalization

a. All digital input and output points shall be setup to accumulate run time information. Maximum run time limits shall be defined and shall automatically issue a printed message as defined by the Owner.

4. Alarms

a. All analog input points shall have upper and lower limits established and alarms shall be generated in the event these limits are exceeded. The Contractor shall define reasonable limits for these alarm points. Digital inputs shall be compared to the associated digital outputs (fan start/stop and status) and alarms shall be issued if the commanded position is inconsistent with the actual condition, after a start

delay timer. All alarms shall be directed to the primary operator workstations and shall be archived on the hard drives.

5. Minimum Runtimes

   a. All digital output points shall have a minimum runtime of five (5) minutes to prevent accidental short cycling.

6. Staggered Starts

   a. All digital outputs shall have staggered start times of at least 30 seconds to minimize demand spikes.

7. Trend Analysis (DDC Controller and all attached TCUs and ASCs)

   a. In order to verify and document satisfactory system operation, at a minimum, all trend logs defined in Appendix A shall be developed and implemented. As work of this Section, all control loops, inter-start delays, minimum and maximum run times, etc., shall be tuned to meet the constraints listed in Appendix A.

   b. All analog and digital trend logs shall be printed in text form with a graph of the corresponding trend data attached as the cover to the text trend data.

   c. All trend graphs shall be printed, maximized in landscape form, on one 8.5" x 11" sheet of paper. Graphs requiring the display of more points than can be reasonable displayed on one graph may be graphed on separate sheet, however, the time stamps of each graph must match exactly so that data from multiple graphs may be compared.

   d. Each analog graph shall include an "x" time/date axis scale and one or two "y" axis scales as required to adequately display the trend data. Each digital trend may be of any style and developed such that overlapping digital sequences are obvious to the viewer. Each axis shall be labeled and scaled. Axis scaling shall be set to clearly show the desired control response and required trend duration. A legend shall be provided clearly defining each trend line. Graphs may be color or black and white, however, black and white graphs must use patterns making the information clearly understandable. The time and date of displayed data shall be provided on both the text trend log printout and the graph printout. Examples of the minimum level of detail that will be required for all trend graphs are included in Appendix B of this Section.

   e. If trend logs are printed and graphed using cryptic systems point names, a legend shall be provided with each trend to make the translation of the trended points easily understood.

   f. All required trends, graphs, and completed point verification forms shall be compiled into a project closeout notebook(s) with tabs indicating the system being trended. For example, point verification forms for AHU-1, the supply air temperature control loop for AHU-1, the static pressure control loop for AHU-1, and the mixed air temperature control loop for AHU-1 shall be included under a tab labeled AHU-1. Zone trend data may be grouped under logical headings by AHU, floor, etc. A complete detailed index of all trend data and graphs shall be included in the front of the notebook(s). A page shall also be included in the front of the notebook identifying who performed which trend log.

   g. The completed closeout notebook(s) shall be provided as part of the close out

documentation required in Section 23 0500. Acceptance of the system will not be given until this requirement is met.

3.4 APPLICATION SPECIFIC CONTROLLERS

A. General

1. A maximum of one ASC shall be installed on each piece of equipment (i.e., blower coil unit, air handling unit, makeup unit, etc.,) and a maximum of one piece of equipment shall be connected to one ASC.

2. Power shall be provided to each ASC and installed in accordance with Division 26 and all applicable codes.

3. All FMS controllers shall be installed in an enclosure that provides protection from the environment and is adequately ventilated to protect against excessive temperature exposure.

B. Input/Output

1. All points listed on the Drawings or required to meet the sequence of operations shall be connected to the respective ASC in accordance with the manufacturer's instructions. Each point shall be checked for voltage, short circuit, etc., prior to termination to the FMS controller to prevent potential damage to the controller.

3.5 TERMINAL UNIT CONTROLLER

A. General

1. A maximum of one (1) TUC shall be installed on each piece of equipment (i.e., fan coil, VAV box, etc.,) and a maximum of one piece of equipment shall be connected to one (1) TUC.

2. Power shall be provided to each TUC and installed in accordance with Division 26 and all applicable codes.

3. All FMS controllers shall be installed in an enclosure that provides protection from the environment and is adequately ventilated to protect against excessive temperature exposure.

B. Input/Output

1. All points listed on the Drawings or required to meet the sequence of operations shall be connected to the respective TUC in accordance with the manufacturer's instructions. Each point shall be checked for voltage, short circuit, etc., prior to termination to the FMS controller to prevent potential damage to the controller.

3.6 OPERATOR INTERFACE PANELS

A. The operator interface panel shall be installed on or near the FMS control panel or as indicated on the Drawings. The panel shall be connected to the FMS network and programmed to allow the functionality described in Section 2.6 of this Specification.

B. The Owner shall be interviewed and all desired passwords and password levels shall be installed at the interface panel.

3.7 NETWORKING/COMMUNICATIONS

A. General

1. All LANs shall be installed in a manner recommended by the manufacturer, owner's representatives, based on the environment, communications speed requirements, and distance. All LAN media shall be installed in a manner that provides protection from physical damage and interference from RF or other electrical sources.

B. Primary Local Area Network (LAN)

1. The primary LAN shall be installed in accordance with all Division 26 communication specification requirements. The Contractor shall provide all conduit, wire, routers, hubs, etc., unless otherwise stated on the Drawings for a complete and operating FMS ETHERNET® communication network. All operator workstations and FMS controllers/routers shall be connected to the LAN.

C. FMS Controller Local Area Network (LAN)

1. The controller LAN shall be installed with materials and procedures that comply with the requirements of the FMS equipment manufacturer. In general, the conductors are to be a 22 gage, low capacitance, and twisted pair. All FMS controllers (if not connected to the primary LAN) and ACS controllers shall be connected to the LAN.

D. Sub-Controller Local Area Network (LAN)

1. The sub-controller LAN shall be installed with materials and procedures that comply with the requirements of the FMS equipment manufacturer. In general, the conductors are to be a 22 gage, low capacitance, twisted pair. All TU controllers shall be connected to the LAN.

3.8 DUCT STATIC PRESSURE STATION

A. Ensure that the direction of flow is observed when installing the probe to prevent measurement of total pressure. The connection between the duct and the flange shall be gasketed and secured with sheet metal screws to prevent any air leakage. Connections from the "HI" pressure port to the differential pressure transducer shall be 1/4" plastic tubing which shall not extend for more than ten feet. Pressure stations shall be installed 2/3 the distance down the duct of all major branch ducts or as indicated on the Drawings.

3.9 OUTSIDE AIR STATIC PRESSURE PROBE

A. Outside air static pressure probe must be installed and piped according to manufacturer's instructions to ensure accuracy of the static pressure reading and eliminate the effects of condensation in the sensing lines. Coordinate installation of probe with the necessary trades for proper sealing of all roof penetrations.

3.10 ELECTRONIC DIFFERENTIAL PRESSURE TRANSMITTER

A. All differential pressure transmitters shall be installed within ten feet of the pressure sensing point. The transmitters shall be installed in a NEMA I housing for interior conditioned spaces and in NEMA 3R housings for outside or unconditioned spaces. The transmitters and housings shall be rigidly supported to prevent vibration and shall never be mounted to ductwork or piping. Access to the transmitter shall be provided.

3.11 ELECTRONIC TEMPERATURE ELEMENT AND TRANSMITTER

A. Space temperature transmitters shall be installed 44" A.F.F. to the center of transmitter unless otherwise noted on the architectural drawings or specifications.

B. All temperature sensors installed in liquid lines, tanks, etc., shall be installed in stainless steel thermowells. The thermowells shall be supplied to the mechanical contractor for installation under other Sections of the Specification. A thermo-conductive paste shall be applied between the sensing element and the thermowell.

C. Outdoor air temperature elements shall be installed in a location that is continuously shaded and not effected by heat generating equipment or equipment intakes or discharges. The element shall be installed under a sun shield and high enough to avoid damage from vandalism.

D. Duct point temperature elements shall be installed directly on ductwork and the connection between the duct and the flange shall be gasketed and secured with sheet metal screws to prevent any air leakage. Care must be taken to avoid direct contact between the temperature element and any heat transfer surface such as a coil.

E. Duct averaging elements shall be installed with the same requirements as for the temperature point elements; however; the averaging elements shall be extended across the entire duct area in a zigzag pattern. Special clips shall be used to secure the elements at turns to prevent chafing of the elements. Where the elements pass through the duct, plastic tubing or similar protection shall be installed on the elements to prevent damage to the elements from vibration.

3.12 AIR FLOW STATION AND TRANSMITTER

A. Pitot Tube Air Flow Element and Transmitter

1. Ensure that the direction of flow is observed when installing the station in the ductwork. The station shall be installed in accordance with manufacturer’s published up- and down-stream duct length requirements.

2. All connection points shall be secured. Connections from the "HI" and "LO" pressure ports to the air flow transmitter shall be 1/4-inch plastic tubing which shall not extend for

more than ten feet.

3. The flow transmitter shall be wall mounted with the display at 60" A.F.F. The flow transmitter shall be completely setup to meet the actual field measurement conditions and output CFM. Provide 24 VAC power for transmitter.

B. Thermal Anemometer Air Flow Station

1. Ensure that the direction of flow is observed when installing the station in the ductwork. The station shall be installed in accordance with the manufacturer's published up- and down-stream duct length requirements. If a suitable location for the flow station cannot be achieved, the Contractor shall consult with the engineer and manufacturer with possible alternative locations.

2. All connection points shall be secured. Provide all power requirements for the unit and connect to the FMS.

3.13 ELECTRONIC HUMIDITY TRANSMITTER

A. Outdoor humidity transmitters shall be installed in a location not affected by equipment that might generate humidity or temperature effects. The transmitter shall be installed where direct moisture (rain) cannot contact the device.

B. Duct point humidity elements shall be installed directly on ductwork and the connection between the duct and the flange shall be gasketed and secured with sheet metal screws to prevent any air leakage. The sensing element shall be located at least ten feet downstream of any coil, humidifier, or dehumidified.

3.14 CURRENT TRANSDUCERS

A. Current transducers shall be installed on one hot leg of either single or three phase and after the local disconnect. The transducers shall be located in the motor starter housing or motor control center and secured to the structure using sheet metal screws.

3.15 CURRENT SENSING SWITCH

A. Current switches shall be installed in one leg of three phase circuits and the hot leg of single phase circuits and in all cases, after the local disconnect. The switches shall be adjusted to close at approximately 10% of the attached loads full load amps.

3.16 AIR DIFFERENTIAL PRESSURE SWITCHES

A. Differential pressure switches shall be connected to pitot tube pickup probes pointing into the air stream on both sides of the process variable. Connection between the switch and the pitot tubes shall be 1/4" hard copper. The switches shall be adjusted to close at approximately 25% of the fans maximum speed or at the dirty filter pressure differential.

3.17 ELECTRIC LINE VOLTAGE THERMOSTAT

A. Where thermostats are to be mounted remotely from the controlled device, all conductors shall be installed in a metallic raceway and the thermostat shall be mounted on a junction box. Provide a locking metallic thermostat guard over the thermostat. Mount the thermostat 48" A.F.F. unless otherwise specified on plans]

3.18 ELECTRIC LOW LIMIT (FREEZESTAT)

A. Low limit thermostats shall be installed with the averaging element extended across the entire duct area in a zigzag pattern. Special clips shall be used to secure the element at turns to prevent chafing of the element. Where the element pass through the duct, plastic tubing or similar protection shall be installed on the element to prevent damage to the element from vibration. The thermostat setpoint shall be set as indicated and the circuit shall be tested to ensure actions as required.

3.19 CONTROL RELAYS

A. Control relays shall be field or panel mounted as indicated on the Drawings. If a relay is field mounted it will be installed in a NEMA I housing.

B. Control relays shall be installed in bases and the based mounted on a DIN rail. All accessories including end clips, jumpers, etc., shall be provided. All wiring shall be labeled. Multiple conductors shall be bundled and run by classification in plastic wireways. Relays shall be labeled as indicated in the shop drawings for ease in troubleshooting.

3.20 CONTROL TRANSFORMERS

A. Control transformers shall be field mounted using a plate to mount on the associated junction box or panel using a foot-style mounting. Locations shall be as identified on the Drawings or as determined by field requirements. A phenolic label on each transformer shall identify the power source by breaker panel and circuit. Fusing of the primary and secondary sides and sizing shall be as defined by the NEC. Provide means of local disconnect for transformer to allow removal.

3.21 AUTOMATIC DAMPERS

A. All automatic control dampers shall be installed under Section 23 3000.

3.22 DAMPER ACTUATORS

A. Electronic Damper Actuators

1. Damper actuators shall be mounted on the damper jack shaft or shaft extender using a V-clamp. The actuator shall then be anchored to the ductwork housing the damper. All power requirements for the actuators shall be supplied under this Section of the Specification.

3.23 CONTROL VALVES

A. The valves shall be installed by the mechanical contractor under other Sections of the Specification.

3.24 CONTROL VALVE ACTUATORS

A. Electronic Valve Actuators

1. Valve actuators shall be supplied factory assembled with the respective control valve.

3.25 ELECTRICAL CONTROL POWER AND LOW VOLTAGE WIRING

A. Comply with all Division 26 installation requirements.

B. Install low voltage control and power wiring in conduit in the following locations regardless of local building code allowances otherwise.

1. Mechanical rooms.

2. Electrical rooms.

3. Vertical risers. (Exception: fire rated continuous closet like a telephone closet.)

4. Open areas where the wiring will be exposed to view or tampering.

5. Hard ceilings and walls.

C. Conceal conduit within finished shafts, ceilings and wall as required. Install exposed conduit parallel with or at right angles to the building walls.

D. Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used provided that:

1. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)

2. All cables shall be UL listed for application; i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose.

3. Class 2 wiring shall be run parallel along a surface or perpendicular to it, and NEATLY tied at ten foot intervals.

E. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

F. All wire-to-device connections shall be made at terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to

devices and terminals.

G. Plug or cap all unused conduit openings and stubups. Do not use caulking compound.

H. Route all conduit to clear beams, plates, footings and structure members. Do not route conduit through column footings or grade beams.

I. Set conduits as follows:

1. Expanding silicone firestop material sealed watertight where conduit is run between floors and through walls of fireproof shaft.

2. Oakum and lead, sealed watertight penetration through outside foundation walls.

J. Cap open ends of conduits until conductors are installed.

K. Where conduit is attached to vibrating or rotating equipment, flexible metal conduit with a minimum length of 18" and maximum length of 36" shall be installed and anchored in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.

L. Where exposed to the elements or in damp or wet locations, waterproof flexible conduit shall be installed. Installation shall be as specified for flexible metal conduit.

M. Provide floor, wall, and ceiling plates for all conduits passing through walls, floors or ceilings. Use prime coated cast iron, split-ring type plates, except with polished chrome-plated finish in exposed finished spaces.

3.26 AIR PIPING

A. Copper tubing shall be supported no less than every 6' and run in a neat professional manner parallel with building lines. Tubing run loose shall be tied to building structures no less than every 6' and bundled where possible. Care shall be taken to avoid chafing at points of connection to the building.

3.27 SMOKE AND FIRE DETECTORS

A. Smoke detectors and the associated wiring shall be installed in accordance with Section 23 0549.

3.28 TEMPERATURE CONTROL PANELS

A. All tubing and wiring shall be clearly labeled with Brady-type marker labels and run to numbered terminal strips or tubing manifolds these wire, tube, and terminal numbers shall be shown on all control diagrams. Wires and tubes shall be labeled at all connection points.

B. All control devices shall be labeled with engraved phenolic tags showing device number and name, model number, setpoint, range, action, etc. Panel Face indicators shall be labeled with engraved phenolic tags identifying what is shown on indicator.

C. Hard tubing shall be brought into the panel using bulkhead fittings; tubing within the panel may be plastic.

D. Electronic digital indicators shall be provided where shown on the Drawings. Indicators shall be LED or LCD loop powered type and fully compatible with the associated transmitter and matched to the range of the transmitters. Indicators shall be flush mounted on the control panel door.

E. Terminal strips shall be provided in all control panels for the termination of all field wiring. An additional 25% but not more than 50 terminal strips shall be provided for future use. Terminal strips shall be rated for no less than 300 VAC, 1/4" in width, track mounted, and a slot provided for labeling strips. All terminals shall be labeled as shown on the as-built drawing. No more than two conductors shall be terminated on a single terminal.

F. Control transformers shall be provided where shown or where required to meet the sequence of operation. Control transformers shall be provided with a phenolic label identifying the source of power.

G. Control panel front mounted pilot lights shall be provided where shown on the Drawings or electrical ladder diagrams. Lights shall have replaceable bulbs and lenses and shall incorporate a "push-to-test" feature. Voltage rating of pilot light may be full load voltage or dropped across a line resistor. In no case may the voltage to pilot lights exceed 120 VAC.

H. Control panels shall have wire ways installed to group all wiring within a panel. Panels shall be manufactured in a professional manner to the satisfaction on the Owner and Engineer.

3.29 CARBON DIOXIDE SENSOR

A. Duct carbon dioxide shall be installed directly on ductwork and the connection between the duct and the flange shall be gasketed and secured with sheet metal screws to prevent any air leakage. The sensing element shall be located at least ten feet downstream of any coil, humidifier, or dehumidified.

B. Space carbon dioxide sensors shall be installed at the same height as space temperature sensors.

3.30 EQUIPMENT CONNECTIONS

A. FMS Class II field wiring for all non-control device applications shall be installed under this Section of the Specification. This includes equipment such as VFDs, chillers, boilers, packaged air handling equipment, etc., that may have point types include status or alarm monitored from an equipment supplier Class C contact or analog control signals to equipment, etc.

3.31 ELECTRONIC LIQUID DIFFERENTIAL PRESSURE TRANSMITTER

A. All liquid differential pressure transmitters shall be installed within ten feet of the pressure sensing points. The transmitter shall be rigidly supported to prevent vibration and shall never be mounted to ductwork or piping. The piping for the sensing points shall include isolation valves such that the transmitter can be removed without having to shut down the liquid system.

Access to the transmitter shall be provided.

3.32 ELECTRONIC LIQUID PRESSURE TRANSMITTER

A. All liquid pressure transmitters shall be installed within ten feet of the pressure sensing ports. The transmitter shall be rigidly supported to prevent vibration if it is not directly connected to the pipe. The piping for the sensing points shall include isolation valves such that the transmitter can be removed without having to shut down the liquid system. Access to the transmitter shall be provided.

3.33 INDOOR STATIC AIR PROBE

A. Indoor static air probes shall be mounted in the ceiling in locations indicated on the Drawings or as required.

3.34 BOILER REMOTE SHUTDOWN SWITCH

A. The manually operated remote shutdown switch or circuit breaker shall be located just outside the boiler room door and marked for easy identification. It should be installed in a location, which safeguards it against tampering. If the boiler room door is on the building exterior, the switch should be located just inside the door. If there is more than one door to the boiler room, there should be a switch located at each door.

3.35 ELECTRONIC HVAC LIQUID FLOWMETER

A. The flow meter/transmitter shall be installed according to the manufacturer's recommendations and tied into the FMS system. All inline meters shall be installed with isolation valves on both sides.

3.36 DOMESTIC WATER SUB-METER

A. The sensors and transmitters shall be installed in accordance with the manufacturer’s installation requirements. All inline meters shall be installed with isolation valves on both sides. A by-pass is not required. The contractor shall connect all outputs from the transmitters and meter to the network per the requirements of these specifications. The contractor shall provide all necessary transformers to provide power for all transmitters and meters.

3.37 GAS SUB-METER

B. The sensors and transmitters shall be installed in accordance with the manufacturer’s installation requirements. The contractor shall connect all outputs from the transmitters and meter to the network per the requirements of these specifications. The contractor shall provide all necessary transformers to provide power for all transmitters and meters.

3.38 MEASUREMENT AND VERIFICATION SYSTEM

C. Install the communications module in a NEMA 1 electrical enclosure with hinged door inside main electrical room near main electrical meter. Connect power supply and Ethernet port.

END OF SECTION 23 0900

APPENDIX A

Verification Trend Log Development and Acceptance Requirements

AHU-1 TREND LOG REQUIREMENTS			
Trend #1 (Supply Air Temperature Control)			
Trend Duration	Sample Interval	Trend Points	Required Response
60 minutes during occupied mode for heating and for cooling	1 minute	SA temperature SA temperature set point Chilled water valve control signal Hot water valve control signal Direct EC control Indirect EC control	SA temperature ±0.5°F of SA temperature SP with hunting of no more than 5% of the control signal
Trend #2 (Supply Air Static Pressure Control)			
Trend Duration	Sample Interval	Trend Points	Required Response
60 minutes during occupied mode	1 minute	SA static pressure SA static pressure set point VFD control signal	SA pressure ±0.05°F of SA static pressure SP with hunting of no more than 5% of the control signal
Trend #3 (Mixed Air Temperature Control)			
Trend Duration	Sample Interval	Trend Points	Required Response
60 minutes during occupied mode	1 minute	MA temperature MA temperature set point Mixing damper control signal	MA temperature ±0.5°F of MA temperature SP with hunting of no more than 5% of the control signal
Trend #4 (Fan Safety Test)			
Trend Duration	Sample Interval	Trend Points	Required Test Sequence
N/A - Allow 2 minutes between test sequence events	1 minute	Fan commanded position Fan (VFD) status Freezestat Condition Supply air smoke detector Return air smoke detector MA damper signal	1) Fan stopped, safeties normal; 2) Fan commanded on, safeties normal; 3) Freezestat tripped; 4) Freezestat reset; 5) SA Smoke detector tripped; 6) SA smoke detector reset; 7) RA smoke detector tripped; 8) RA smoke detector reset;

ZONE CONTROLLER TREND LOG REQUIREMENTS			
Trend #1 (Space Temperature Control Range Test)			
Trend Duration	Sample Interval	Trend Points	Required Test Sequence
N/A - Allow full system response recovery between test sequences	1 minute	Space temperature Space temperature set point HW valve control signal Primary air control damper signal Primary air flowrate Primary air flowrate set point Primary air flowrate maximum Primary air flowrate minimum	1) Space temperature at or near set point; 2) Adjust space temperature set point 3.0°F below actual temperature; 3) Adjust space temperature set point 3.0°F above actual temperature; 4) Return space temperature set point to design condition;
Trend #2 (Space Temperature Control)			
Trend Duration	Sample Interval	Trend Points	Required Response
24 Hours – including transitions from unoccupied to occupied and occupied to unoccupied modes	10 minute	Space temperature Space temperature set point	Space temperature remains within ±0.5°F of space temperature set point with hunting of no more than 5% of the control signal for the hot water or primary air flow rates.

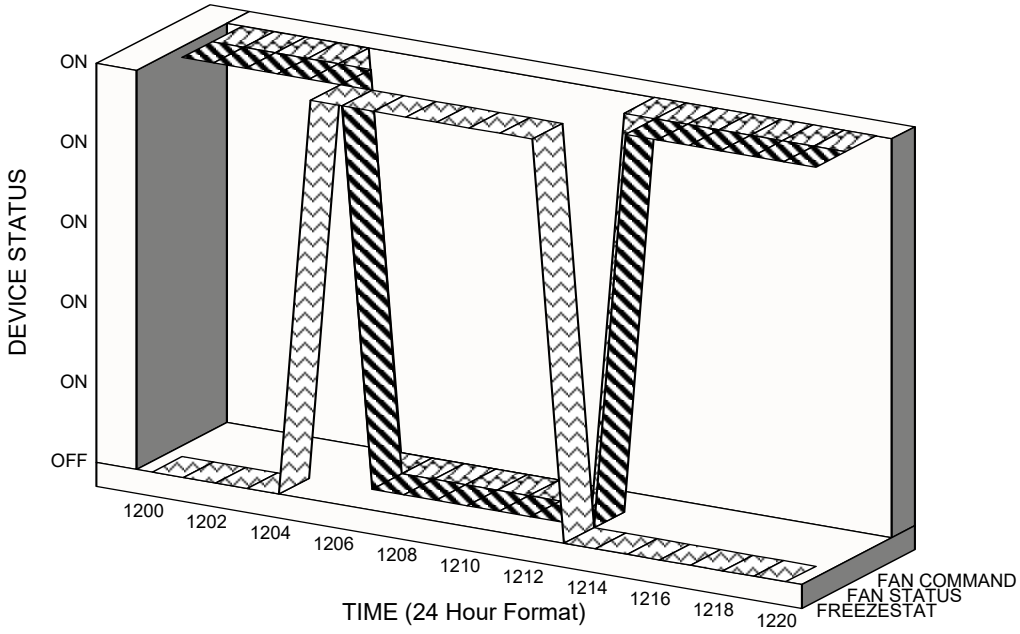
SECONDARY HOT WATER SYSTEM TREND LOG REQUIREMENTS			
Trend #1 (Differential Pressure Control)			
Trend Duration	Sample Interval	Trend Points	Required Response
60 minutes	1 minute	HW differential pressure HW differential pressure set point Control signal to VFD #1 Control signal to VFD #2	Differential pressure remains within ±1.0 PSID
Trend #2 (Differential Pressure Setpoint Control)			
Trend Duration	Sample Interval	Trend Points	Required Response
24 Hours – including transitions from unoccupied to occupied and occupied to unoccupied modes	10 minute	HW differential pressure HW differential pressure set point Maximum position of all HW valves Minimum position of all HW valves	Set point resets so that one or more of the chilled water coil valves is between 90% and 100% open with hunting of the differential pressure set point less than 1.0 PSIG
Trend #2 (Pump Automatic Switchover Control Test)			
Trend Duration	Sample Interval	Trend Points	Required Test Sequence
N/A - Allow full system response recovery between test sequences	1 minute	HW differential pressure HW differential pressure set point HW pump #1 commanded position HW pump #1 status HW pump #1 control signal HW pump #2 commanded position HW pump #2 status HW pump #2 control signal	1) HW pump #1 on in lead position and in control; 2) Manually shut off the VFD serving HW pump #1; 3) Repeat steps #1 & #2 with HW pump #2 as the lead pump

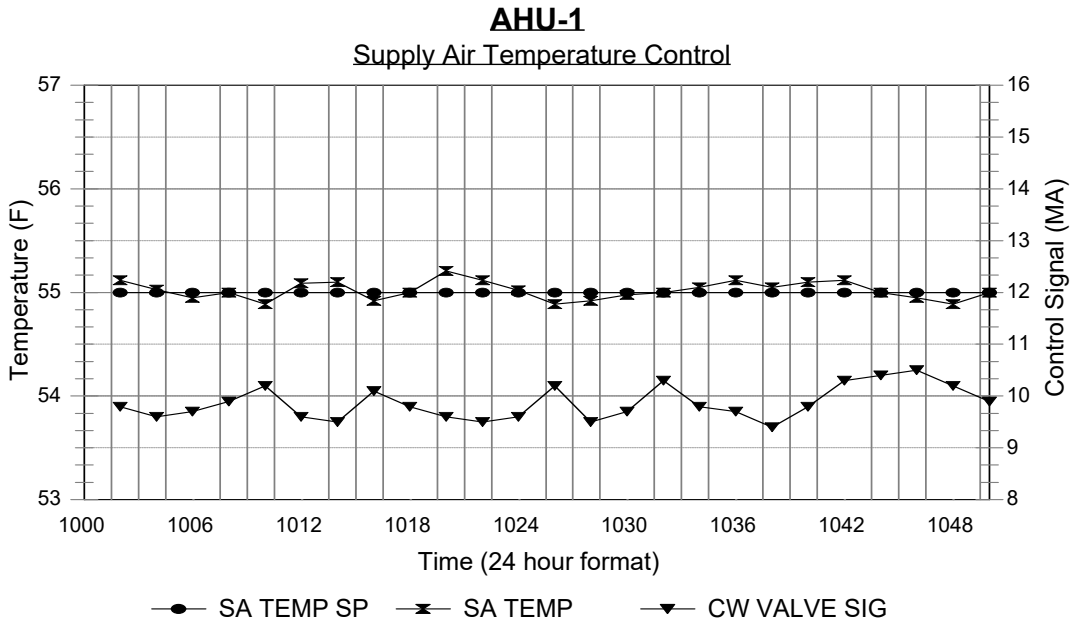
APPENDIX B

Typical Trend Graph Requirements

AHU-1

Fan Safety Sequence Test




AHU-1
Supply Air Temperature Control
Temperature (F)
Control Signal (MA)
57
56
55
54
53
16
15
14
13
12
11
10
9
8
1000
1006
1012
1018
1024
1030
1036
1042
1048
Time (24 hour format)
SA TEMP SP
SA TEMP
CW VALVE SIG

APPENDIX C
Typical Point Verification Form

POINT VERIFICATION FOR AHU-1						
Point Description	Software Point Name	Point Type	Date Tested	Results (Pass/Fail)	Contractor Initials(1)	Inspector Initials(2)
SA Temp Sensor	AH1SATMP	AI	11/1/99	Pass	RTC	ALM
SA Static Press	AH1SASTAT	AI	11/1/99	Pass	RTC	ALM
Fan S/S	AH1SAFSS	DO	10/14/99	Pass	RTC	ALM
Fan Status	AH1SAFST	DI	10/14/99	Pass	RTC	ALM
Freezestat(3)	AH1FZ	DI	10/13/99	Pass	RTC	ALM
CW valve control	AH1CWV	AO	10/14/99	Pass	RTC	ALM

(1) RTC is Robert T. Conbert of Acme Control Company, Inc.
(2) ALM is Albert L. Mackey, P.E. of Zebra Commissioning Company, Inc.
(3) Freezestat is also hard wired to stop fan in the hand or auto position. These interlocks were tested on the same day.

SECTION 23 2113 - HEATING HOT WATER SYSTEM AND EQUIPMENT

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Conform with applicable provisions of the General Conditions, Supplementary Conditions and General Requirements.

1.2 RELATED SECTIONS

A. Section 23 0500 for Common Work Requirements for HVAC.

B. Section 23 0504 for Pipe and Pipe Fittings.

C. Section 23 0505 for Piping Specialties.

D. Section 23 0523 for Valves.

E. Section 23 0700 for HVAC Insulation.

F. Section 23 5233for Finned Water-Tube Boilers

G. Section 23 0900, Facility Management System, for temperature control valves, meters and instrumentation.

H. Section 23 5216 – Condensing Boilers

I. See Division 26, Electrical.

PART 2 - PRODUCTS

2.1 PIPING

A. Hot water heating piping shall be black steel pipe A53 grade A or B, seamless ERW or BW, standard wall Schedule 40 through 10" diameter. Larger diameter pipe shall have wall thickness as follows:

Pipe Diameter, Inches	Wall Thickness, Inches
12" & larger	0.375
14" & Larger	0.500

B. Contractor may use Type L hard drawn copper tubing, ASTM B88 for hot water piping sizes 2" and smaller. Proper insulating fittings, as specified in Section 230504, shall be installed to prevent electrolytic action between steel and copper piping connections.

2.2 FITTINGS

A. Fittings for steel piping, 2" and smaller, shall be either screwed or welded. Screwed fittings shall be either Class 150, standard black malleable iron conforming to ANSI B16.3 or Class 125, standard black cast iron conforming to ANSI B16.4. Weld fittings shall be either standard weight steel butt-welding fittings conforming to ANSI B16.9 or forged steel socket-welding fittings, 2000 pound Schedule 40 conforming to ANSI B16.11.

B. Fittings for steel piping, 2-1/2" and larger shall be either standard weight steel butt-welding fittings, conforming to ANSI B16.9.

C. Fittings for copper piping shall be wrought copper conforming to ANSI B16.22, with 95-5 solder joints, as specified in Section 23 0504.

2.3 FLANGES

A. Flanges for steel piping system shall be forged steel, weld neck or slip-on, 1/16" raised face Class 150 flanges conforming to ANSI B16.5.

B. Flange connections for valves and equipment shall match the rating and drilling of the valves and equipment furnished.

C. Where specifically required by the application, black cast iron Class 125, standard threaded plain face companion flanges may be utilized for flanged connections in threaded piping systems.

D. Gaskets shall be 1/16" thick ring type or full face non-asbestos material suitable for the temperatures and pressure application,

E. Flange bolting shall be carbon steel machine bolts or studs and hex nuts, ASTM A307, Grade B.

2.4 VALVES

A. Valves other than automatic control valves are specified in Section 230523, HVAC Valves.

B. Automatic control valves shall be as specified in Section 230900, Facility Management System.

2.5 HOT WATER BOILER

A. Refer to Section 23 5216 – Condensing Boilers

2.6 PUMPS

A. Pumps shall be of the type and capacity listed in the Equipment Schedule and specified in Section 23 2123. Pumps shall be selected so that the motors will not overload under any operating condition. Furnish one spare mechanical seal of each size required in conjunction with the pumps furnished under this Contract. All pumps shall have drain pans with tapped pipe connections and 3/4" drain line extended to floor drain. Pumps shall be installed so that

they may be removed without the removal of the associated piping.

2.7 HOT WATER UNIT HEATERS

A. Hot water unit heaters shall be propeller fan type, arrangement type as scheduled, adjustable discharge louvers for horizontal type, louver cone diffuser for projection type, hot water entering at 170 degrees F, and leaving at 150 degrees F. Furnish remote wall mounted electric 115-volt thermostat and safety fan guard. Trane, McQuay, or equivalent.

2.8 COILS

A. Hot water heating coils shall be as specified in Section 23 3000, and listed in the Mechanical Equipment Schedule.

2.9 EXPANSION TANK

A. Expansion tank shall be of the pressurized diaphragm type as specified in Section 23 0505 and listed on the Mechanical Equipment Schedule on the drawings.

2.10 WATER TREATMENT

A. Water treatment system, including shot type feeders shall be furnished by the Contractor.

B. Tanks shall be connected to the supply and return mains by means of 3/4" pipe with valves in each connection and with a 3/8" test cock on the supply connection. Tanks shall be wall or floor mounted on steel support adjacent to system pumps. The Contractor shall provide complete installation of water treatment equipment as shown on the drawings and as required by the Water Treatment Agency.

C. Chemicals as required for the system startup, operational testing and commissioning shall be provided by the Water Treatment Agency in sufficient quantities to maintain the level of chemical concentration recommended by the Water Treatment Agency and shall be included in the contract price. The exact type of chemical treatment compounds shall be determined by the Water Treatment Agency and approved by the Owner's Representative.

D. As a part of the contract price, the Contractor shall provide a one (1) year water treatment service contract by the Water Treatment Agency. Service contract shall include onsite testing on not less than a monthly basis and all required chemicals during the one (1) year project warranty period.

E. After system acceptance by the Owner, the continuing water treatment will be the Owner's responsibility.

2.11 FLOW MEASURING STATIONS

A. Furnish and install water flow measuring station and automatic flow control valves where shown on the drawings and as specified in Section 23 0505.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping installation shall conform to the requirements of Section 23 0500, Common Work Requirements for HVAC, Section 23 0504, Pipe and Pipe Fittings. Installation of specialties shall conform to the requirements of Section 23 0505, Piping Specialties.

3.2 CLEANING AND FLUSHING PIPING SYSTEMS

A. New heating water piping systems installed under this Contract shall be chemically cleaned of oils, greases, dirt and mill scale. The new piping system shall be inspected by the Owner's approved Water Treatment Agency to determine the appropriate cleanout procedures and recommended cleaning chemical materials.

B. Cleaning shall be performed in strict accordance with the chemical treatment agency and manufacturer's recommendations, and shall generally consist of the following:

1. Fill, flush, and drain piping systems with water to remove loose dirt and debris from the system.

2. Refill piping system with cleaning compounds, diluted to recommended concentrations and circulate for required time period.

3. Drain and flush system.

4. Neutralize using caustic and soda ash as required when cleaning with acid compounds.

5. Drain and inspect system and repeat cleaning if necessary.

C. In conjunction with piping system cleaning, clean and inspect all strainers and suction diffusers. Remove, bypass, or otherwise protect as necessary all piping system components which may be damaged due to chemical cleaning, including filters, instrumentation gauges, flow meters, etc.

D. After completion of chemical cleaning and flushing, the piping system shall be immediately refilled and maintained with treated water. Under no circumstances shall cleaned piping be allowed to sit empty or filled with untreated water.

3.3 TESTS

A. All piping shall be proven tight at a hydrostatic pressure of 150% of the system design operating pressure, but not less than 125 PSI. The system shall show no loss in pressure or indication of leakage at any joint or connection for a period of one (1) hour.

END OF SECTION 23 2113

SECTION 23 2123 - PUMPS

PART 1 - GENERAL

1.1 SCOPE OF SERVICES

A. Supply pumps as specified herein, including freight to job site. Coordinate with Contractor for delivery and proper installation. Align pumps, instruct Owner's operating personnel in proper operation and maintenance, and provide two sets of O&M Manuals.

1.2 WARRANTY

A. Provide parts and labor warranty for 18 months from shipment, 12 months from beneficial use. Warranty service must be guaranteed within four hours of notice, 24 hours per day, and 365 days per year.

1.3 SUBMITTALS

A. Five sets within one week after award: Full shop drawings for pumps and motors including assembly drawings; materials of construction; seal; motor HP, insulation, manufacturer, and full load motor efficiency; coupling; pump curve; and NPSH required.

PART 2 - PRODUCTS

2.1 PUMPS

A. General:

1. Factory assembled packaged pump and motor of bronze-fitted, cast iron construction, single-state, suitable for scheduled conditions of service. Entire assembly shall be finished with a suitable coating for long-term corrosion resistance.

2. General: Pump and motor mounted on steel or cast iron baseplate suitable for grouting in place, with raised lip drip pan and tapped drain connection. Coordinate rotation with piping and equipment layout.

3. Pump and motor capacities and efficiencies: Pump capacities shall be minimum as scheduled, and suitable for parallel operation. Motors shall not exceed HP listed. Unit shall operate over the entire pump curve without exceeding the motor nameplate rating. Supplier may deviate from the pump and motor efficiencies listed as long as the total electric power required to drive all pumps does not exceed the total power per the schedules, and as long as no motors change in size.

4. Pump characteristics: Curve shall rise continuously from maximum capacity to shutoff, operation at or near peak efficiency, capable of operating over entire flow range listed at

full speed without exceeding breakoff point or exceeding manufacturer's recommendations. Impeller diameter shall not exceed manufacturer's minimum published diameter plus 90 percent of the difference between published maximum and minimum impeller diameters.

5. Casing: close grain cast iron, 175 psig rated, with 125 psi ASA flanges, plugged drain and vent connections, and replaceable bronze wearing rings.

6. Impeller: Centrifugal type, total enclosed, non-overloading, one-piece bronze impeller, with entire rotating assembly statically, dynamically and hydraulically balanced.

7. Shaft: Carbon steel, minimum AISI C1045.

8. Motor: Squirrel cage induction type, 1.15 service factor, Class B insulation, and premium efficiency per IEEE Standard 112, Test Method B, 460/3/60, non-overlooking and suitable for continuous operation at any point along the pump curve.

9. Bearings: Grease lubricated, moisture and dust resistant housing, minimum 20,000 hour B-10 life (100,000 hour average life) under scheduled conditions of service.

10. Coupling: Flexible type with removable guard, similar to Waldon, Thomas, Falk, Fast or Woods.

B. Horizontal Split Case Type: Double suction type, ODP motor, and 316 stainless steel shaft sleeve.

1. Mechanical seals: Single, unbalanced, inside mounted, end face rubber bellows type with stainless steel spring, brass or stainless steel seal heads, carbon-graphite rotating washer, and renewable tungsten-carbide stationery seat, similar to John Crane Type 1. Supply one spare seal of each size. Aurora Type 410.

C. End Suction Type:

1. Aluminum-bronze shaft sleeve, mechanical seal with brass and buna-carbon-ceramic seal, and bronze casing wearing ring. Suitable for pumping water at 200°F. Aurora Type 340.

D. In-Line Recirculating

1. Cast iron body, bronze fitted with mechanical seal. Bell & Gossett, Taco, ITT or Grunfos.

2.2 APPROVED MANUFACTURERS

Bell & Gossett
Aurora
Peerless
Armstrong
Groundfos
Weinman
Taco

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate rotation with drawings.

B. Prior to shipment clean flanges and exposed machined metal surfaces and treat with anti-corrosion compound. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

C. Provide pump foundations as indicated on drawings. Install pumps on foundations. Affix to base using either anchor bolts or expansion anchors.

D. Provide piping, valves, strainers, and instrumentation as indicated.

E. Align pumps per manufacturer's recommendations, but not less than within 0.002 inches. Grout pumps into place after alignment using non-shrink grout.

F. For pumps with variable speed drives provide a technician to set up drive as specified herein. Demonstrate proper system operation.

G. Supplier shall submit a written report stating that pumps are properly installed, aligned and operating.

H. Provide minimum two 2-hour training sessions for Operating Personnel.

END OF SECTION 23 2123

SECTION 23 2313 - REFRIGERANT PIPING SYSTEM AND EQUIPMENT

PART 1 GENERAL

1.1 REQUIREMENTS

A. Conform to the applicable provisions of the General Conditions, the Supplemental General Conditions and the General Requirements.

1.2 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements for HVAC.

B. Section 23 0504, Pipe and Pipe Fittings.

C. Section 23 0505, Piping Specialties.

D. Section 23 0523, Valves.

E. Section 23 0700, HVAC Insulation.

F. Section 23 0900, Facility Management System**,** for temperature control valves, meters and instrumentation.

G. Division 26, Electrical.

H. Refrigerant piping, insulation, and accessories associated with medical equipment and kitchen equipment furnished under other sections of this specification shall be furnished and installed by the equipment sub-contractors and is not a part of Division 23.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.4 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Five (5) years from date of Substantial Completion.

b. For Parts: Five (5) years from date of Substantial Completion.

c. For Labor: Five (5) years from date of Substantial Completion.

1.5 QUALIFICATION PROCEDURES

A. The storage, handling, and transportation of all refrigerants, oils, lubricants, etc. shall be accomplished in strict compliance with all State, local, and Federal Regulations including all requirements set forth by the Environmental Protection Agency (EPA) for the safe handling of regulated refrigerants and materials. The Contractor shall utilize qualified and/or certified personnel and equipment as prescribed by these requirements. In no situation shall any refrigerant be discharged to the atmosphere.

PART 2 PRODUCTS

2.1 INDOOR AND OUTDOOR UNITS – 3 TON AND SMALLER

A. Indoor Units shall be as specified on the Equipment Schedule on the drawings and Section 23 3000.

B. Air-conditioning and heat-pump indoor units shall be Daikin, Mitsubishi (or approved equal) split system with Variable Speed Inverter Compressor technology. The system shall consist of a wall or ceiling mounted (see plans) indoor section with wired, wall mounted controller and a horizontal discharge, single phase outdoor unit.

C. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.

D. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

E. The units shall be rated in accordance with Air-conditioning Refrigeration Institute’s (ARI) Standard 210 and bear the ARI Certification label.

F. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001, which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

G. A dry air holding charge shall be provided in the indoor section.

H. The outdoor unit shall be pre-charged with R-410a refrigerant for 150 feet of refrigerant tubing.

I. The electrical power of the unit shall be 208 volts or 230 volts, 1 phase, 60 hertz. The system shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts. The power to the indoor unit shall be supplied from the outdoor unit, using the Daikin Control system. For A-Control, a three (3) conductor AWG-14 wire with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units.

J. The control system shall consist of two (2) microprocessors, one on each indoor and outdoor unit. Field wiring shall run directly from the indoor unit interconnected by a single non-polar two-wire AWG-16 stranded cable to the wall mounted controller with no splices. The control system between the outdoor unit and indoor unit shall be supplied from the outdoor unit using the Daikin Control system. The system shall be capable of automatic restart when power is restored and after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostic codes for indoor and outdoor units shall be displayed on the wired controller panel. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from the wired controller, providing emergency operation and controlling the outdoor unit.

K. The indoor unit shall be connected to a wall mounted wired controller to perform input functions necessary to operate the system. The wired controller shall have a large multi-language DOT liquid crystal display (LCD) presenting contents in English and Spanish. There shall be a built-in weekly timer with up to eight pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Heat/Auto/Cool/Dry/Fan mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Vane Position selector, a Louver Swing button, a Ventilation button, a Test Run button, and a Check Mode button. The controller shall have a built-in temperature sensor. Temperature shall be displayed in either Fahrenheit (°F) or Celsius (°C). Temperature changes shall be by increments of 1°F (1°C) with a range of 67°F to 87°F (19°C to 30°C).

L. The wired controller shall display operating conditions such as set temperature, room temperature, pipe temperatures (i.e. liquid, discharge, indoor and outdoor), compressor operating conditions (including running current, frequency, input voltage, On/Off status and operating time), LEV opening pulses, sub cooling and discharge super heat.

M. Normal operation of the wired controller shall provide individual system control in which one wired controller and one indoor unit are installed in the same room. The controller shall have the capability of controlling up to a maximum of sixteen systems at a maximum developed control cable distance of 1,500 feet (500 meters).

N. The control voltage from the wired controller to the indoor unit shall be 12 volts, DC. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Up to two wired controllers shall be able to be used to control one unit.

O. Control system shall control the continued operation of the air sweep louvers, as well as provide On/Off and mode switching. The controller shall have the capability to provide sequential starting with up to fifty seconds delay.

P. Provide Hail Guards for outdoor condensing coils.

2.2 20 TON AND LARGER OUTDOOR AIR COOLED CONDENSER

A. Furnish and install air cooled condensers located as shown on the drawings. Air cooled condenser shall be of type and capacity as specified in the Mechanical Equipment Schedule on the drawings. All condensing units are factory assembled and wired. Unit frames are constructed of 14 gauge welded galvanized steel with 14 and 16 gauge galvanized steel panels and access doors. The unit surface is phosphatized and finished with an air-dry paint to withstand 500 hours of continuous salt spray solution in accordance with ASTM B117. Decorative louvered panels provide condenser coil protection.

B. Compressor - R-410A Scroll compressors have simple mechanical design with only three (3) major moving parts. Compressors shall be completely enclosed compression chamber with no leakage paths. The compressor is suction gas cooled, direct drive, 3600 RPM hermetic motors. The Scroll compressor includes a centrifugal oil pump, oil level sight glass, and an oil charging valve.

C. Refrigerant Management - Each compressor shall have crankcase heaters installed, properly sized to minimize the amount of liquid refrigerant present in the oil sump during off cycles. Additionally, the condensing unit shall have controls to initiate a refrigerant pump down cycle at system shut down on each refrigerant circuit. To be operational, the refrigerant pump down cycle requires a field-installed isolation solenoid valve on the liquid line near the evaporator.

D. Condenser Fan and Motors - R-410A Vertical discharge direct-drive fans are statically and dynamically balanced. Fan motors are three-phase with permanently lubricated ball bearings, built-in current and thermal overload protection.

E. Microchannel Condenser Coil -l R410A Condenser coils are dual circuit having an all Aluminum Microchannel design. The coils are burst tested and leak tested. Factory installed liquid line service valves are standard.

F. Provide Hail Guards for outdoor condensing coils.

G. Refrigerant Circuit - R410A Each unit has two independent refrigeration circuits with 3 compressors per circuit piped in parallel. Six step capacity control is accomplished through compressor cycling.

H. Standard Ambient Control - R410A Standard ambient control allows unit operation from 40 F to 115 F .

I. Roof curb – 24 inches tall with 2” spring isolators.

1. Prefabricated Vibration isolation curb to be manufactured of prime galvanized steel construction, 14 gauge, meeting ASTM A653/653M, with welded corners and with seams joined by continuous water and air tight welds. Vibration isolation curb shall be internally

reinforced with bulkheads 48” on center and factory installed wood nailer. Top of all Vibration isolation curb shall be level, with pitch built into curb when deck slopes. Vibration isolation curb shall be designed to provide a minimum of 90% isolation efficiency with 2” deflection. 9” continuous rubber cover around perimeter of Vibration isolation curb over spring isolators. Thybar Vibro-Curb III or equivalent.

J. Pressure Gauges - R410A Pressure gauges are mounted adjacent to compressors to monitor suction, discharge and differential oil pressure for each refrigerant circuit.

K. Service Valves - R410A. Provide isolation valves at each refrigerant piping connection in order to isolate compressors for servicing. This valve is a refrigerant shut off valve.

L. Provide Hot Gas Bypass refrigerant line from condensing unit to evaporator inlet.

M. Factory-Installed electrical power wire termination and combination starter/disconnect enclosure.

N. The disconnect shall be rated for adequate interrupting capacity (Short Circuit).

O. Manufacturers

1. Manufacturers: Manufacturer of the Air Cooled Condensing unit shall be the same as the manufacturer of the air-handling unit in 23 7313. Subject to compliance with requirements, provide products by one of the following:

2. York

3. Trane Company.

2.3 PIPING

A. Refrigerant piping materials and installation shall be in accordance with the best working and piping practices for Freon refrigerants. The Contractor shall install the refrigerant piping using Type "L" hard drawn copper tubing, Federal Specification WW-T-749, with silver solder joint. All piping shall be installed in a straight manner, free from traps, and shall be provided with plugged or capped ends, as it is erected, to prevent dirt from entering. The piping system shall be provided with gauges as required for the operation of the system. Refrigerant piping layout and routing shall be approved by manufacturer of the condensing unit and engineer of record prior to installation.

2.4 VALVES

A. Expansion valves shall be of the thermostatic type as manufactured by Alco, Sporlan, or equivalent, and shall be gas charged with capillary tube, external superheat adjustment and external equalizing connection. The expansion valves at each apparatus shall be protected by a strainer in the refrigerant liquid line to that group. The strainer shall be as manufactured by the Henry Valve Company, or equivalent, not less than line size and provided with shut-off valves before and after, and furnished with the packaged reciprocating unit.

B. Solenoid valves shall be suitable for the system in which they are used and shall be designed specifically for use with Freon refrigerants. Solenoid valves shall be furnished with the packaged reciprocating unit.

C. Refrigerant line valves shall be packless type or packed type with gas tight cap seal with wheel, globe, angle, or "T" needle type, with hard metal seats and shoulders on stems to permit packing stuffing boxes while open under pressure, or sealed diaphragm type.

2.5 DRYER

A. In each liquid line, install a suitable silica gel filter and dryer. Dryer shall be furnished with the chiller.

PART 3 EXECUTION

3.1 INSTALLATION

A. Piping installation shall conform to the requirements of Section 23 0500, Common Requirements for HVAC, and Section 23 0504, Pipe and Pipe Fittings.

B. Install units level and plumb.

C. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

D. Install roof-mounted, compressor-condenser components on roof skids.

E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

E. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and retest as specified above.

I. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

3.5 INSTALLATION

A. Piping installation shall conform to the requirements of Section 23 0500, Common Requirements for HVAC, and Section 23 0504, Pipe and Pipe Fittings.

3.6 TESTING OF REFRIGERANT PIPING SYSTEM

A. After the installation of the refrigerant piping system has been completed, all piping shall be tested and proven tight for a period of twenty four (24) hours at a pressure of 150 lbs. per square inch using dry nitrogen.

3.7 EVACUATION AND CHARGING

A. Upon completion of the piping pressure test, the refrigerant circuit shall be evacuated to 500 microns using a closed tube manometer and a high vacuum pump (using an electronic vacuum gauge that reads in microns) to ensure tightness of the piping and to remove air and moisture from the piping system. Upon completion of evacuation and acceptance of the system tightness, the vacuum shall be broken by the introduction of the refrigerant.

3.8 REFRIGERANT AND LUBRICATING OIL

A. Contractor shall furnish and install all of the refrigerant required to develop the system to its full rating, and in addition to the initial charge, the Contractor shall be required to provide all refrigerant required for the proper operation of the refrigeration apparatus during the first season's operation. Contractor shall guarantee that the loss of refrigerant for a season's operation shall not exceed 10% of the full charge of the system and he shall furnish any refrigerant required above this amount. This guarantee shall remain in effect until such time as the Contractor shall demonstrate this performance for one full year's operation. The Contractor

shall be required to provide the initial charge of lubricating oil for all refrigeration apparatus and related equipment, and shall furnish a chart listing the type of oil and a schedule for maintenance that should be used with the various equipment.

3.9 PRESSURE RELIEF DEVICES

A. Refrigerant pressure relief devices and fusible plugs shall be installed with piping to a safe location in accordance with ANSI/ASHRAE Standard 15-1994. Discharge shall be to atmosphere at a location not less than 15 feet above the adjoining ground level and not less than 20 feet from any window, ventilation opening, or exit from any building. Discharge line sizing shall conform to ANSI/ASHRAE Standard 15-1994.

B. Each discharge pipe shall be equipped with a drip leg capable of holding 1 gallon of liquid. The drip leg shall include a manual drain valve.

END OF SECTION 23 2313

SECTION 23 3000 - AIR TEMPERING SYSTEM AND EQUIPMENT

PART 1 GENERAL

1.1 REQUIREMENTS

A. Provide all products, labor and services necessary to construct and demonstrate proper functionality of the HVAC and exhaust systems indicated on the drawings and specified herein.

B. Conform with applicable provisions of the General Conditions, the Supplemental General Conditions and General Requirements.

C. See Sections 23 0500, 23 0548, 23 0549, 23 0593, 23 0700, and 23 0900 for additional requirements.

D. Comply with the Equipment General Requirements in Spec Section 23 0500.

1.2 SCOPE

A. Install control dampers supplied under Section 23 0900. Adjust dampers for smooth operation.

1.3 SUBMITTALS

A. Submit the following for review and approval:

1. All equipment shown on the equipment schedule and elsewhere on the drawings. Submit evidence or certification that equipment complies with ASHRAE Std. 90.1.

2. Ductwork construction standards, sheet metal, plenums, ductwork accessories, etc.

3. Flues and vents: Materials of construction and accessories. For vents with horizontal offsets or expansion joints, submit layout for review.

4. Dampers for fire and smoke control: For each type of damper proposed, submit manufacturer's literature demonstrating compliance with all aspects of the specifications and drawings. Submit manufacturer's installation instructions.

5. Air Filters and Filter Gauges

6. Grilles, Registers & Diffusers: Configuration, materials of construction, finish, mounting details, and performance data including throw, static-pressure drop, and noise ratings. Submit for type only, but supplier shall check and verify that the indicated diffuser type and sizing are appropriate for each area. Advise of any concerns in any areas.

7. Terminal Units:

   a. Submit the following for each type of unit: Unit construction, materials, and wiring diagrams.

   b. Submit the following for each size unit: Dimensional data, recommended flow ranges, and performance data (pressure drop and sound data) at maximum flow.

   c. Submit a schedule showing the following for each terminal unit indicated on the drawings: Tag number, max & min CFM, size, pressure drop, and heating system performance.

8. Layouts of systems covered by this section of the specifications. Layouts shall be at a scale appropriate for the areas shown. Include large scale sections as appropriate.

1.4 QUALITY ASSURANCE

A. Comply with the following codes & standards:

1. UMC 2021 Chapter 6 – Duct Systems

2. UMC 2021 Standard 6-2, Standard for Metal Ducts

3. SMACNA 2013 HVAC Duct Construction Standards – Metal and Flexible, including Addendum 1 dated 11/1997

4. SMACNA Round Industrial Duct Construction Standards – 2013

5. SMACNA Rectangular Industrial Duct Construction Standards – 2005

6. NFPA-90A-2012 - Standard for the Installation of Air-Conditioning and Ventilating Systems

B. Component Characteristics

1. All components within ducts and plenums shall be non-combustible or shall have a flame spread less than 25 and smoke developed less than 50 when tested as a composite product per NFPA 255, ASTM E84, or UL 723, except where specifically permitted by the UMC and noted in the drawings or specs.

1.5 SOUND LEVELS

A. Sound levels attributable to mechanical equipment are designed to result in sound levels of NC 40 for offices, conference rooms, and NC 35 for library, classrooms, etc., measured within the rooms. Mechanical equipment that has been substituted for the specified equipment shall perform within the specified equipment sound limitations, or will be replaced or adjusted as required. Sound levels attributable to duct vibration that result in noticeable noise or vibration to duct hangers, lighting fixtures, ceiling tees or diffusers shall be re-supported or adjusted until the disturbing noise is brought within acceptable limits.

1.6 DIMENSIONS

A. Compare all drawings and verify all dimensions both on the drawings and in the field before laying-out, cutting, and fabricating the work.

B. Refer to Section 23 0500, Common Work Requirements for HVAC, for coordination drawing requirements.

PART 2 PRODUCTS

2.1 DUCTWORK AND PLENUMS

A. Materials: Construct all ducts, casings, plenums etc. from galvanized steel sheets except as indicated. Sheets shall be free of blisters, slivers, pits, and imperfectly galvanized spots. Reinforcing angles and bars, and duct support materials shall be same material as ductwork if exposed to the air stream, or galvanized steel if not exposed to the air stream.

1. Galvanized Steel: Per ASTM A653/A653-03 Standard Specification for Steel Sheet, Zinc-Coat (Galvanized) or Zinc-Iron Alloy-Coat (Galvanized) by the Hot Dip Process, with minimum 1.25oz/sf zinc.

2. Aluminum: Alloy 3003-H14

3. Stainless Steel: 340SS, provide No. 2B finish in exposed areas

4. Fiberglass Ductwork (Ductboard): Use only where specifically noted. Minimum 1-inch thick, 3 lb. density rigid fiberglass ductboard with glass fiber reinforced vapor barrier, UL Class 1, labeled on each board per UMC-06 Standard 6-5.

a. Properties:

1) Thermal conductivity for 1-inch thickness shall not exceed 0.22 Btuh/SF-F at 75 deg F

2) Noise reduction coefficient of 0.80 on Mounting No. 6.

b. Tape: 3-inch "Hardcast" mineral impregnated woven fiber tape with an actuator/adhesive applied in accordance with the manufacturer's directions, or thermlok heat sensitive tapes. Pressure sensitive tapes will not be accepted.

c. Owens-Corning Fiberglass, Johns Manville, Certain-Teed or equivalent. Flexural rigidity (E.I.) average shall not be less than 475.

5. Polyvinyl Coated Galvanized Steel: Minimum 4 mil polyvinyl coating. Foremost Manufacturing Company, Southfield, Michigan. Model PCD 4 by 1 for exterior coating only, or Model PCD 4 by 4 for both interior and exterior coating.

B. Flexible Ducts: Factory fabricated, listed as a Class 1 Air Duct per UL 181 with aluminum foil interior liner, corrosion resistant helix mechanically locked to fabric to ensure dimensional stability, helix separated from air stream, 1.5-inch fiberglass insulation with conductance not to exceed 0.23 Btuh-in/Hr-SF-F, and fire retardant outer vapor barrier. Ducts shall be rated at 12-

inch positive pressure, 5-inch negative pressure, 0.1 perm per ASTM E96, and -20 to +250°F. Flexmaster Type 3, Technaflex 57K, OAE.

C. Ductwork Accessories

1. Sealers: Water based, for use on galvanized steel and with the other materials specified herein, suitable for use at -20 to +200°F and duct pressures to 10 inches wg, dry to the touch within 12 hours, sufficiently flexible to pass a 0.25-inch mandrel test, listed per UL-181A & 181B, and suitable for storage and application at 40–110°F. Approved Manufacturers: Carlisle Coatings & Waterproofing "Hardcast," Foster, RCD, AM Conservation Group, OAE.

2.2 SHEET METAL ACCESSORIES

A. Dampers: Factory fabricated, suitable for use with air at -20 to +240°F, galvanized steel housing and blades except as noted, rated for indicated pressures in either direction and performance rated per AMCA-500.

1. Shafts: Square or hexagonal steel, 3/8-inch or 1/2-inch, continuous through damper, mechanically fastened to damper blade, and extending through frame as required for actuator or locking quadrant.

2. Bearings: Provide for each side of each shaft, molded synthetic or stainless steel sleeve type.

3. Multi-blade dampers: Except as indicated, provide parallel-blade for 2-position applications and opposed blade for modulating applications. Provide jackshafts as required to drive large dampers.

4. Air pressure drop shall not exceed:

a. Dampers rated at 1500 FPM: ____ in wg at 1500 FPM

b. Dampers rated at 4000 FPM: ___ in. wg at 4000 FPM

5. The dampers described in this section are assigned Type Numbers D1 through D23. The following table summarizes key characteristics of each type of damper. Drawings and Part 3 – Execution, indicate which type of damper to use in each application.

Type	Shape	Blade	Max Size (inches)	Multiple Sections	Rated Velocity (FPM)	Rated Shutoff Press. (in. wg)	Seals	Leakage (CFM/SF @ 1 in. DP)	Notes	Ruskin Model
D1	Rect	Flat	36 x 12	No	1500	2.5	No	--	1	MD15
D1	Rect	3V	48 x 48	No	1500	2.5	No	--	1	MD15
D2	Rect	Flat	36 x 12	No	1500	2	No	--	1	MD25
D3	Rect	3V	48 x 48	Yes	1500	2	No	80	1	MD35
D4	Rect	3V	48 x 72	Yes	1500	2.5	No	40		CD35
D5	Rect	3V	48 x 72	Yes	1500	2.5	Yes	4		CD36
D6	Rect	Airfoil	60 x 72	Yes	4000	6	Yes	2	2	CD50
D7	Rect	Airfoil	60 x 72	Yes	4000	6	Yes	2		CD60
D20	Round	Flat	20	No	1500	2	No	40	1	MDSR25
D21	Round	Double	40	No	4000	10	Yes	4		CDR25
D22	Round	Double	24	No	4000	6	Yes	6		CDSR25
D23	Oval	Double	72 x 24	No	4000	10	Yes	4		CDO25

Note 1: Provide locking hand quadrant and 2-inch standoff bracket

Note 2: Aluminum Construction

B. Flexible Connectors: Except as noted flexible connectors shall be heavy fiberglass cloth; coated to be air tight, water tight, fire retardant; suitable for temperatures of -20 to +200° F; rated for 10 in. wg positive or negative; with tensile strength minimum 450 lb/inch in the warp and 340 lb/inch in the filling. Provide flexible connectors in 3-3-3 configuration, with 3-inch galvanized steel strip along each edge and 3-inches of flexible fabric in the center.

1. Standard Applications: Flame spread 20, smoke developed 40, Ventfabrics Ventglas OAE

2. Applications Exposed to Sun and Weather: Double coated with du Pont Hyphalon, Ventfabrics Ventlon OAE.

3. Applications from 200 – 500° F: Tensile Strength 285 lb/inch in the warp and 185 lb/inch in the filling. Ventfabrics Ventsil OAE

4. Corrosive Applications: Teflon coated, Ventfabrics Ventel OAE.

C. Duct and Plenum Access Doors: Galvanized steel, gasketed. Size as required to properly inspect and service components located within the ductwork. Ruskin, Acudoor, Ductmate, OAE.

1. Rectangular ducts up to 2-inch positive or negative SP: Minimum 22 gauge frame and door thru 12-inch size, 20 gauge door for larger sizes, double gasketed (between door and frame, and between frame and duct) with cam locks, either hinged or removable. Ruskin ADH22, ADC22, ADHW22, or ADCW22, Ventfabrics, OAE

2. Round or Rectangular Ducts to 12-inch Positive Pressure: Removable oval sandwich style with gasketed inner door, insulated outer door, and large hand knobs. Ruskin ADR and ADF.

3. Ducts to 12-inch Negative Pressure: Ruskin ADHP-3.

4. Plenum Access Doors: Factory fabricated frame and door rated to 4-inch positive or 8-inch negative pressure. Provide mill finish and neoprene seals to limit leakage to less than 0.1 CFM/inch perimeter with door closed. Doors shall open against air pressure.

   a. Frame: Extruded aluminum with 1.5-inch flange and mitered corners

   b. Door: Extruded aluminum mitered frame, double wall 24-gauge galvanized steel panel with minimum R-5 insulation isolated from the air stream, full-length piano hinge and two heavy-duty latches similar to Ventlok 310.

   c. Approved Manufacturers: Ruskin GPAD or approved equal.

D. Turning Vanes:

1. Single wall: Per SMACNA HVAC Duct Construction Standards Figure 2-3 & 2-4.

2. Double wall: Airfoil shape with smoothly rounded entry nose and extended trailing edge, minimum 2” x 3” vane crossection, hot dipped galvanized steel, 26-gauge vanes, 24-gauge runner, each vane double pinned to each runner, field adjustable to required elbow aspect ratio. Performance shall not exceed the following for a 24 x 24 elbow at 2000 FPM average: Air pressure drop 0.105 in. wg; aound generated 54 dB re 10^-12 watts. Aero/Dyne Co. Model HEP, Airsan, Elgen, or equivalent.

E. Roof Curbs and Equipment Support Rails: Factory fabricated, minimum 12-inch high, galvanized steel, configured to account for roof pitch where pitch exceeds 1/4-inch/ft or where required by manufacturer of supported equipment. Coordinate with roofer and provide cant and step if needed to match roof construction.

1. Roof Curbs: 1.5-inch fiberglass insulation with nominal 2" x 2" wood nailer. Provide damper tray where a damper is indicated. Thycurb TC, Greenheck, OAE.

2. Equipment Support Rails: Nominal 2" x 4" wood nailer. Thycurb TEMS, Greenheck OAE

F. Louvers: 4-inch extruded 6063-T5 aluminum alloy frame and blades with flange, mill finish, and 1/2-inch galvanized steel bird screen.

1. Structural: Suitable for 100 MPH wind loading when supported along the perimeter only for sizes up to 90” x 120”. Intermediate mullions and supports if provided as part of louver, shall not be visible from the exterior.

2. Air Pressure Drop: Less than 0.20 in wg at 470 FPM over gross area, intake or exhaust per AMCA 500 based on 48 x 48 test sample.

3. Moisture Penetration: Less than 0.01 oz/sf over 15 minute test per AMCA-500 at 470 FPM intake over gross area based on 48 x 48 test sample.

4. Ruskin ELF375D OAE.

G. Acoustic Louvers

1. Ruskin ACL 1245, 12 inches deep, with 45 degree blade angle, 22 percent free area (48" x 48" typical unit with .15 inch w.g. maximum pressure drop, at 4277 cfm air flow). Frame and blade material shall be galvanized steel. Free field noise reduction shall be:

Band Frequency (Hz)		63	125	250	500	1000	2000	4000	8000
Reduction (db)	14	13	15	20	23	22	20	20	

2. Provide bird-screen, steel channel frame, Ruskatherm blanket insulation, and perforated steel interior surface that covers insulation.

H. Thermometers: As specified in Section 23 0505.

I. Barometric Pressure Balance Dampers: Air Balance, Inc. units with adjustable counter weight, aluminum air foil design blades, nylon bearings. Match frame assembly to wall or duct.

2.3 FLUES AND VENTS FOR FUEL-FIRED EQUIPMENT

A. General: Factory-built metallic vent system, UL Listed components. Each component shall bear indication of its UL listing.

1. Heat Resistant Paint: Glidden, Metallite OAE.

2. Approved Vent Manufacturers: Metal Fab, Metalbestos, Schebler, Ampco, OAE.

B. Type IV Vent: For use with Category II or Category IV appliances (natural gas or propane-fired, positive or negative pressure, condensing, not exceeding 550^{o} F exhaust temperature). Listed per UL-1738, double wall with 1-inch clearance and spacers to maintain alignment.

1. Inner Pipe: AL2904C superferritic SS manufactured by Allegheny Ludlun, with welded seams, connected with V-bands, and sealed with high temperature silicone sealant. Rated at 6 inches water. Thickness: 0.015-inch through 12-inch size; 0.024-inch for 14-inch and larger sizes.

2. Outer Pipe: Seal with V-band of same material as outer pipe. Provide silicone sealant for portions exposed outdoors. Thickness: 0.018-inch through 12-inch size; 0.024-inch for 14-inch and larger sizes.

3. Options and Accessories:

a. Outer Wall: Aluminized steel 304 SS.

4. Metal Fab Type CG

2.4 DAMPERS FOR FIRE AND SMOKE CONTROL

A. General: Factory assembled and UL listed as an assembly, suitable for horizontal or vertical air flow and for ducted or un-ducted applications. Fire dampers (FDs) shall be listed per UL 555, smoke dampers (SMDs) shall be listed per UL 555S, and fire/smoke dampers (FSDs) shall be

listed per UL 555 and UL 555S. Units shall be galvanized steel except as noted. Approved manufacturers: Greenheck, Ruskin, Potorff, or approved equal.

B. Combination Fire/Smoke Dampers: Factory assembled complete with damper, actuator, thermal link, and all specified accessories, all mounted on a sleeve.

1. Construction: Round blades, rectangular parallel blades and rectangular opposed blades are acceptable, except dampers shall be rectangular opposed blade type when installed in any of the following conditions: within 10 diameters of a fan or supply register, within 3 diameters of an elbow. Internal frames in rectangular FSDs shall be low profile type for ducts 17"H and less.

2. All components factory installed and wired, including actuator, thermal link, position switches, temperature over-ride (if specified), test switch (if specified), etc. Mount all such components on outside of FSD sleeve to the side of duct (not top or bottom) except where indicated or approved. FSDs must be suitable for rotating the unit 180-degrees so these components can be on either side of the duct.

3. Air pressure drops shall be certified per AMCA 500D. Pressure loss coefficient C_o shall not exceed the following when tested per AMCA Figure 5.3:

Size (in)	3-V Blade	Airfoil Blade	Round
12 x 12	2.41	2.01	NA
24 x 24	0.65	0.60	NA
36 x 36	0.44	0.27	NA
12 x 48	0.76	0.91	NA
12 Round	NA	NA	0.33
24 Round	NA	NA	0.23

4. Listed for installation within wall, floor or ceiling assemblies as indicated on drawings.

a. Ratings, except as noted: 1.5-hr Fire Rated, Leakage Class 1, 350°F, 4-inch Static Pressure, Dynamic.

1) Up to 1600 FPM: Greenheck FSD-211 (3-V blade type), OFSD-211, or FSDR-511 (round).

2) Up to 3000 FPM: Greenheck FSD-311 or 311V (airfoil blade) or OFSD-311.

b. 3-Hr Rated Walls: Greenheck FSD-231.

c. Stainless Steel: Greenheck SSFSD-211 or SSFSDR-511 (round).

5. Actuators: Electric 2-position, 115/1/60 (provide factory wired transformer if required), normally closed, spring return, NEMA-1 except as noted. Actuator shall fully re-open damper when power is restored after any power interruption.

6. Accessories

a. Transitions: Provide round-to-rectangular, oval-to-rectangular, or rectangular-to-rectangular transitions as appropriate for the application.

b. Thermal Link: Provide re-settable bi-metallic thermal link to initiate closure when the air temperature within the duct rises to 165° F. Where indicated provide

thermal links for operation at 212° F, 250° F, or 350° F. Thermal link shall be easily resettable from outside the duct.

c. Position Switches: Provide dry contacts for remote monitoring of damper open and closed positions.

d. Retaining plates and angles: Provide as required. Galvanized steel specifically designed for the particular FSD and included as part of the UL Listed assembly.

e. Installation decals: Provide installation decals on the sleeve which give the installer clear installation instructions.

f. Temperature Override Control: Provide controls so that the thermal link can be over-ridden and the FSD opened for smoke control, even if the air temperature exceeds the setting of the thermal link, provided the temperature does not exceed 350° F.

C. Smoke dampers: Similar to fire/smoke dampers noted above, except as follows:

1. Smoke dampers shall comply with UL 555S, but need not comply with UL 555.

2. Smoke dampers need not have a fire rating.

3. The thermal link and temperature override are not applicable.

4. Suitable for installation within a wall, floor or ceiling assemblies as indicated.

a. Ratings, except as noted: Leakage Class 1, 350° F, 4-inch Static Pressure, Dynamic.

1) Up to 1600 FPM: Greenheck SMD-201 (3-V blade type) or SMDR-501 (round).

2) Up to 3000 FPM: Greenheck SMD-301, 301V (airfoil blade) or SMDR-401.

b. 6-inch pressure rated: Similar to Greenheck SMD-401

c. Stainless Steel: SSSMD-201 & SSSMDR-501 (round).

D. Fire Dampers: Dynamic rated, suitable for closing against 8-inch differential pressure. Curtain type with sleeve and 165°F replaceable fusible link, resettable. Provide round-to-rectangular, oval-to-rectangular, or rectangular-to-rectangular transitions as appropriate.

1. 1.5-hr rated: Greenheck DFD-155

2. 3-hr Rated: Greenheck DFD-355.

3. Provide 212° F fusible links for high temperature applications.

E. Ceiling Radiation Dampers: UL Classified for use with fire rated floor/ceiling assemblies, with 165°F fusible link replaceable through the damper assembly, 1.5-hr rated except as noted. Greenheck CRD-1, CRD-2 (round), CRD-60, or CRD-60X. Provide 212° F fusible link and 3-hr rated dampers where indicated.

2.5 FILTERS AND FILTER GAUGES

A. Rated per ASHRAE Std. 52.1; Class 1 or 2 per UL Std. 900; glass fiber media; suitable for operation from -20° F to +170° F; corrosion resistant; suitable for installation with pleats either horizontal or vertical, and for air flow horizontal, vertical upflow, or vertical downflow; suitable for face velocity up to 625 FPM. Unless specified elsewhere, pre-filters shall be MERV-7, and final filters (where specified) shall be MERV-14. AAF, Camfil Farr, or approved equal.

		MERV RATING						
		7	11	14	11	14	11	14
Description							High Capacity	
Configuration		2-inch or 4-inch	12-inch Cartridge		6-inch Cartridge		12-inch Cartridge	
Initial Resistance	in. wg.	0.26	0.25	0.58	0.39	0.58	0.29	0.49
Rated Velocity	FPM	500	500	500	500	500	500	500
Max Velocity	FPM	625	625	625	625	625	750	750
Recommended Final Resistance	in. wg.	0.7	1.5	1.5	1.5	1.5	1.5	1.5
Gross Media per 24 x 24 Filter	SF	14 Pleats per foot	62	62	105	125	175	175
Housing		Cardboard	Polystyrene or Aluminized Steel	Polystyrene or Aluminized Steel	Polystyrene or Aluminized Steel			
Frame		Channel	Gasketed		Gasketed		Gasketed	
AAF Model		Perfect Pleat	VariCel RF		VariCel M-Pak		VariCel V	
Camfil Farr Model		3030	RigaFlow					

B. Filter Gauges: Provide a filter gauge for each bank of filters. Gauges shall be magnehelic type with static pressure tips and inter-connecting piping. Ranges shall be 0-1 inch w.g. for all filters except bag filters which shall have a range of 0-2 inches w.g.

2.6 GRILLES, REGISTERS AND DIFFUSERS

A. Refer to section 23 3713.

2.7 FANS

A. General

1. Construction

a. Factory fabricated fan, motor, drive and accessories, listed per **UL** , with air flow rated per AMCA 211 and sound rated per AMCA.

b. Fan wheel: Statically & dynamically balanced, with shaft sized so first critical speed is minimum 25% above maximum operating speed.

c. Motor and Drive: Premium efficiency ODP motor per Spec Section 23 0500, direct drive or belt driven as indicated in schedule on drawings, bearings with 100,000 hr L-10 life.

1) Variable Speed Applications: Provide Class F insulation.

d. Belt Drives: Adjustable pitch sheave up to 5 Hp, fixed pitch above this Hp, cast and machined pulleys with all components sized for 150% of motor Hp.

e. Dampers:

f. Accessories:

1) Roof Curb: Minimum 18-inch galvanized steel, fiberglass insulated, with wood nailer, damper tray and flange. Provide cant and step if needed for proper seal with roof.

2. See Section 23 0548 for Vibration Isolation requirements.

B. Centrifugal Roof Exhaust Fans

1. Leakproof construction.

2. Housing: Spun aluminum construction, reinforced wind band welded to one-piece curb cap with mounting holes on the side and integral spun venturi, spun aluminum motor compartment with readily removable cover and breather tube. All other structural components shall be galvanized steel.

3. Fan wheel: Backward inclined, centrifugal, non-overloading.

4. Motor and Drive: Motor out of the air stream, cooled with ambient air. Motor, drive and fan wheel resiliently mounted on neoprene isolators.

5. Electrical: Disconnect NEMA-1 if protected from the weather, or NEMA-3R if exposed to the weather, wired to motor, with all wiring and components per NEC and either UL Listed or UL recognized.

6. Accessories: Stamped aluminum nameplate, hinge kit to allow tilting fan up to inspect wheel, retaining chains, conduit chase and roof curb.

7. Approved Manufacturers: Greenheck, Cook, ACME, OAE.

C. Propeller Sidewall Mounted Exhaust Fans

1. General Description:

a. Fan arrangement shall be exhaust.

b. Sidewall mounted applications

c. See equipment schedule for performance.

d. Maximum continuous operating temperature 130 Fahrenheit (54.4 Celsius)

e. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number

f. Assembly shall be UL listed.

2. Wheel:

   a. Propeller shall be aluminum blade riveted to steel hub

   b. A standard square key and set screw or tapered bushing shall lock the propeller to the motor shaft

   c. Statically and dynamically balanced in accordance with AMCA Standard 204-05

   d. The propeller and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency

3. Motors:

   a. Motor enclosures: Totally enclosed fan cooled to meet UL-705. Motors are permanently lubricated, sleeve bearing type on sizes 8-12 and ball bearing type on sizes 14-24 to match with the fan load and furnished at the specific voltage and phase

   b. Accessible for maintenance

4. Drive Frame:

   a. Drive frame assemblies and fan panels shall be galvanized steel

   b. Drive frame shall have welded wire or formed channels and fan panels shall have prepunched mounting holes, formed flanges and a deep formed one piece inlet venturi

5. Disconnect Switches:

   a. NEMA rated 1

6. Options/Accessories:

   a. Finishes:

   b. Types: Baked Enamel

7. Wall Housing:

   a. Mounting arrangement: Flush Interior

   b. Constructed of galvanized steel with heavy gauge mounting flanges and prepunched mounting holes

   c. Housing shall include OSHA approved motor guard

   d. Grille.

8. Wall Collar:

   a. Constructed of galvanized steel with heavy gauge mounting flanges and prepunched mounting holes

9. Motor Side Guard:

   a. Guard type: OSHA Guard

b. Protective guard completely enclose the motor and drive side of the fan

c. Coated with Permatector, a thermal setting polyester urethane.

10. Local Controls:

a. Fan shall be controlled by local thermostat. Provide thermostat and all accessories as needed.

2.8 COILS

A. Galvanized steel casing, copper tubes and aluminum fins except as noted, with tubes mechanically expanded into fins, circuited to allow completely draining and venting coil, drain and vent connections, with performance rated per ARI. Do not exceed scheduled air or water pressure drops by more than 5 percent.

2.9 PACKAGED ROOFTOP AIR CONDITIONING UNITS 2-12.5 TONS

A. General

1. Acoustical performance shall be established per ARI 260 rating procedures. Measurements will be taken in an ANSI 12.32 qualified room using a calibrated reference source per ARI 250. Sound data supplied shall meet or be less than requirements established later in this Specification. (Data presented in dBA, sones, Bels is not acceptable.)

2. Test one unit per ARI 260 at a qualified independent lab. Unit will be selected by Engineer. Unit will be tested prior to release for production of other units. If unit fails to pass the discharge, inlet and radiated sound tests modify unit and re-test until unit passes.

B. Packaged AC Units, 2 – 12.5 Tons

1. General: Factory fabricated with ductwork connections as indicated on the drawings, suitable for rooftop installation, UL listed, ARI rated, factory piped and wired requiring only a single field power connection, factory run-tested, with casing, cooling section, gas heating section, fan section, accessories and controls.

2. Casing: Heavy gauge galvanized steel, weatherproof with exterior surfaces phosphatized and finished with baked enamel, hinged or removable panels for access to all components, water and air-tight seals for access panels, minimum 1/2-inch insulation, and hoods for intake and relief air. Provide a location for locating a fused disconnect on exterior of unit.

3. Cooling Section: Suitable for operation down to 55^{o} F ambient, hermetic compressors, evaporator and condenser coils with copper tubes mechanically expanded into aluminum fins, all necessary refrigerant accessories, all necessary safety and operating controls, and double-pitched condensate pan. Provide fan guard for condenser fans.

4. Heating Section: Gas-fired, SS burner, corrosion resistant heat exchanger, direct spark ignition, forced draft or induced draft fan, all necessary safety and operating controls, complying with California requirements for low NOx emissions.

5. Fan Section: Forward curved centrifugal, direct drive, with thermally protected motor, resiliently mounted.

6. Economizer: May be field installed, automatic motorized intake damper for 0 – 100% outside air intake, dry bulb type, with relief damper.

7. Accessories: 2-inch MERV 7 filters, 12-inch insulated roof curb with wood nailer and with cant and/or step if required to coordinate with roof.

8. Controls: Factory wired 24V microprocessor controls with controls transformer and thermostat for wall mounting.

9. Approved Manufacturers: Trane, Carrier, York, OAE.

C. Options & Accessories:

1. Casing: 2-inch double wall construction with perforated interior liner, minimum 14-inch roof curb, special sound curb, SS drain pan.

2. Electrical and Control: Unfused disconnect, convenience receptacle, remote human interface panel

3. Refrigeration: R-134a, R-410a, R-407C automatic hot gas bypass, low ambient controls and all components to allow operating refrigerant system down to 0°F

4. Gas Heat: Minimum 80%efficient, 4:1 modulating control, SS heat exchanger

5. Filters: As specified elsewhere in this spec section, 2-inch MERV 7 with 12-inch MERV-13 cartridge final filters**.** Filters shall be located within the unit, not within the curb.

6. Fan(s): Fan and motor mounted on common steel base with seismically restrained spring isolators sized for minimum 2-inch static deflection. Provide supplyand relief or return/relief relief fan with VFD with three contactor bypass. Provide extended lube lines.

7. Air Economizer: Automatic air-side economizer with OA damper and controls to fully modulate OA from 0 – 100%.

   a. Controls: Dry bulb type

   b. Relief Air: Variable speed relief fan with 2-position motorized relief damper or variable speed return/relief fan with modulating return and relief air dampers.

   c. OA and motorized relief damper: Leakage not to exceed 1% at 1-inch wg per AMCA Std. 575. OA and relief dampers: Air flow measuring type accurate to within 10% from 25% - 100% of scheduled air flows.

8. Approved Manufacturers: Trane , York/Johnson Controls, Daikin Applied, Carrier, OAE

PART 3 EXECUTION

3.1 DUCTWORK AND PLENUMS

A. Ductwork

1. Construct ductwork with wall thicknesses and reinforcing per the SMACNA HVAC Duct Construction Standards, Second Edition, 1995, and UMC 2009 Chapter 6,

2. Pressure Classes: Construct ductwork to the following pressure classes:

Duct Element Description	Relative Pressure	Pressure Class
From Outside Air Louver to Filter:	N	1"
From Air Handling Unit to Terminal Unit:	P	4"
From Single Zone AHU to Diffuser	P	2"
From Terminal Unit to Diffuser:	P	1"
From Return Grille to Fan:	N	1"
From Return Fan to Relief Louver:	P	1"
From Exhaust Register to Exhaust Fan:	N	2"

3. Sealing: Seal ductwork and plenums as follows:

----------Seal Class----------

-----Supply Ducts----

Location	≤2 in. wg	≥2 in wg	Exhaust	Return
Outdoors	A	A	C	A
Unconditioned Spaces	B	A	C	B
Conditioned Spaces including RA Plenums	C	B	B	C

Seal Class	Description
A	All transverse joint, longitudinal seams and duct wall penetrations.
B	All transverse joints and longitudinal seams.
C	Transverse joints

a. Apply duct sealer to inside of seams and joints. Do not use pressure sensitive tape as the primary sealant.

4. Clearance to earth: Maintain minimum 4-inch separation between ductwork insulation and earth.

5. Openings in Ductwork: During installation protect the open ends of ducts to prevent debris and dirt from entering.

6. Provide turning vanes in square elbows of low velocity supply and exhaust ductwork.

7. Collars: Where exposed ducts pass through walls, floors, or ceilings, provide a tight-fitting, flanged sheetmetal collar around duct and tight against finished surface to cover opening and present a neat appearance. Lock collar to duct.

8. Cross Breaking: Cross-break low velocity rectangular sheetmetal ducts on all four sides. Cross break sheet metal between standing seams or reinforcing angles. The center of cross break shall be of the required height to assure surfaces being rigid. Do not cross-break high velocity plenum panels.

9. Grilles Registers and Diffusers: Install plumb, affix to general construction as appropriate, make air-tight connection to ductwork, and adjust air flow pattern to achieve appropriate velocities in the occupied zones. Request direction from Engineer if any question exists regarding proper air flow adjustment.

10. Duct Thermometers: Provide thermometers to indicate mixed air, outside air, and supply air of indoor air handling units over 2,500 cfm and where shown on the Drawings.

11. Test Holes: Provide test holes in ducts at locations where testing is required per Section 23 0593 and as requested by the T&B agent. Close test holes with rubber plugs. Reseal all insulated ductwork with the same insulation, jacket and vapor barrier material after T&B is complete.

12. Closure Systems:

    a. Rigid Air Ducts: Comply with UL 181A – Standard for Closure Systems for Use with Rigid Air Ducts and Air Connectors.

    b. Flexible Air Ducts: Comply with UL 181B – Standard for Closure Systems for Use with Flexible Air Ducts and Air Connectors.

13. Factory Made Air Ducts: Install in accordance with the terms of their listing and the manufacturer's recommendations.

14. Acoustic Insulation: See Section 23 0700, HVAC Insulation. Fabricate ductwork so the dimensions indicated on the drawings are the clear dimensions for air flow inside the acoustic insulation.

15. Coordination with Building Construction

    a. General: The drawings show the general intended configuration of the ductwork. Provide additional offsets where necessary to coordinate with the building construction or with the work of other disciplines. Transition ductwork as required at no change in contract price. Where this is necessary, submit for review and maintain the indicated flow areas.

    b. Ductwork is frequently routed through bar joists and between bar joists. Coordinate duct locations with joist submittals prior to fabrication.

B. Special Applications

1. Moisture Laden Ductwork: Stainless steel with all joints liquid-tight by continuous external welding. Welds shall be free from pits, runs, spatter and other imperfections. Pitch horizontal ductwork downward to intake opening. Where traps occur that collect

water, provide a 1/2-inch half coupling welded to the bottom of the duct and pipe to spill over nearest drain. Include a properly sized trap in the drain piping.

2. Fume Hood Ductwork: Stainless steel with seams and joints continuously welded on the exterior. Spiral lock seam is not acceptable.

3. Shower Room Exhaust Ductwork: Aluminum

4. Ducts Handling Corrosive Vapors: Either stainless steel or galvanized steel with internal polyvinyl coating constructed and sealed as noted.

5. Underslab Ductwork: Galvanized steel, polyvinyl coated on the exterior, constructed and sealed for 2-inch SP, insulated per Section 23 0700, and concrete encased. Concrete thickness shall be as indicated on the drawings, but not less than 2-inch thick.

   a. Take care to prevent damaging ductwork when concrete is poured. Work with and provide guidance to the contractors responsible for pouring concrete and responsible for installing the building moisture protection system.

   b. Anchor ductwork not more than 4-ft on centers to prevent floating. Use minimum 12-gauge wire or 16-gauge straps. Protect openings in ductwork with wood or metal blocking.

   c. Pour concrete in maximum 12-inch lifts with each layer being allowed to set before pouring the next. Do not use power vibrators shall not be used in placement of concrete on or around ducts.

6. Fiberglass Ductwork (Ductboard)

   a. Provide fiberglass ductboard only where specifically indicated on the drawings and in this specification.

   b. Install per UMC-09 Standard 6-05 – Standard for Installation of Factory-Made Air Ducts and SMACNA Standard 1884-2003 – Fibrous Glass Duct Construction Standard.

   c. The drawings indicate required clear inside dimensions for air flow.

   d. Where a duct constructed of ductboard penetrates a wall or floor which requires a fire damper, smoke damper, or fire/smoke damper, install the FD, SMD or FSD in the wall per its listing, make sheet metal connections to the damper if required, and then transition back to ductboard.

7. Exterior Ductwork: Install ductwork as specified herein and insulate per Section 23 0700. Then enclose the exposed top and sides of ductwork with 28 gauge galvanized steel or 26-guage aluminum to protect the insulation. Repair any damage to the insulation jacket. Slope sheet metal enclosure to shed water.

C. Hangers and Supports

1. Securely support ducts per SMACNA and UMC Table 6-7. Provide support at each concentrated load and at each change in direction. Provide supports on each side of rectangular ducts and equipment. Where vertical ducts pass through floors or roofs, support with angles or other steel members attached to minimum two opposite sides of duct. Size supports to rigidly support the ductwork. Provide lateral support.

2. Hangers for terminal units: Minimum four 1" x 1/8" galvanized steel straps or two angle trapeze supports.

3. Horizontal Round Ducts: 30 inches and larger in diameter: Provide 2" x 2" x 1/8" black steel rolled angle ring on 6-ft centers, and support from angle.

D. Plenums

1. Single Wall Plenums: Shop fabricated minimum 16 gauge galvanized sheet steel. Horizontal and vertical panels are to be fabricated of 2' x 10' sheets. Unless otherwise dimensioned on the Drawings, access door frames are not to exceed 16-3/4 inch width. Where door width exceeds 16-3/4 inches, vertical panels shall be fabricated around 2" x 2" x 1/4" angle. If the plenum height or width exceeds 9 feet, provide a 2-1/2" x 1/8" continuous galvanized steel strip between each horizontal and vertical seam. Provide high velocity cement at each joint during panel assembly. Panels are to be bolted as shown on the details or tack welded at the Contractor's option; however, enough panels must be bolted to allow removal of equipment from the plenums. Cover interior surfaces with 2-inch thick, acoustical lining.

   a. Plenum Access Doors: Minimum two fastening devices that can be operated on either side of the door; these devices to be readily operated and moving parts to have bronze pins. All parts of the door shall be constructed of galvanized iron and shall be airtight. Latches: "Ventlock" No. 310 OAE.

2. Double Wall Plenums: Factory fabricated, Semco or equivalent. Submit shop drawings for review including overall configuration, construction details, access doors, erection drawings and structural calculations stamped by a registered structural engineer,.

   a. Factory fabricated, minimum 18 gauge galvanized steel outside, perforated galvanized steel inside, with 2-inch sound insulation between. Plenums downstream of final filters shall have solid inner panel.

   b. Heat transfer coefficient shall not exceed 0.0575 BTUH/SF-F at 75 deg F mean temperature. Pressure Ratings: 12 in. wg positive and 10 in. wg negative.

   c. Noise attenuation shall be as follows in decibels, re 10^{-12} watts.

		OCTAVE BAND							
		1	2	3	4	5	5	7	8
Attenuation, db:	26	30	36	41	34	36	44	37	
Noise Absorption Coeff:	0.22	0.39	1.20	1.36	1.03	0.84	0.74	0.68	

3.2 DUCTWORK ACCESSORIES

A. Dampers: Install dampers with shafts horizontal. Locate dampers so that actuators are readily accessible. Verify that dampers operate smoothly.

1. Manual Dampers (Balancing Dampers): Damper Types D1 through D23 are all suitable for use as manual balancing dampers. Provide locking quadrants.

2. Automatic Applications: The following damper types may be used for automatic applications: D4, D5, D6, D7, D21, D22 and D23. Provide damper actuators per Section 23 0900.

B. Flexible Connectors: Provide flexible connectors at locations indicated on the drawings and at the inlet and outlet of each fan directly connected to duct system. Select flexible connectors appropriate for the application. Provide steel spring vibration isolators spanning across flexible connections of isolated fan housings to prevent blow-apart due to horizontal displacement of fan housings.

C. Access Doors: Provide as required for access to all components located within ductwork. Locate to facilitate access to such components. Size as appropriate. In addition to locations specifically called out on the drawings or elsewhere in these specs, provide access doors at the following: FDs, SMDs, FSDs, instrumentation mounted within ductwork, fan bearings.

D. Turning Vanes: Provide turning vanes in square elbows of all supply ducts. Single wall turning vanes may be used in ducts up to 1500 FPM and 24-inch vane length. Provide double wall turning vanes in ducts exceeding either of these criteria.

E. Roof Curbs and Equipment Support Rails: Coordinate the location of roof curbs and rails with the roof structure, ductwork distribution, and other work. Install after roof deck is installed but before roof is insulated. Mount curbs and rails securely to deck per manufacturer's recommendations. Provide counterflashing as required.

F. Louvers: Coordinate louver size and construction with structural and architectural openings to assure proper fit. Securely fasten louver to internal structural members to withstand a force of 25 lb/sf plus a safety factor of 3.0.

G. Instrumentation: Install duct thermometers and filter gauges so they are easily readable from the operator level.

3.3 FLUES AND VENTS FOR FUEL-FIRED EQUIPMENT

A. General: Install per the drawings and these specifications, manufacturer's instructions, the terms of the vent's UL Listing, the UMC and NFPA-211.

1. Use the same type vent for the entire system from the equipment connection to the termination outside. Provide all fittings, transitions, adapters, supports, storm collars, etc.

2. Install per the venting requirements of the appliance manufacturer. Comply with clearances per UL Listing. Minimize offsets and resistance to flow. System shall develop a positive flow adequate to remove products of combustion to outside. Do not run any portion of the vent system through any supply or return air duct or plenum. Do not connect the vent from any Category I or II (non-positive pressure) appliance with any Category III or IV (positive pressure) appliance. Do not install any manually operated damper at any point in vent system.

3. Properly support the system and make provisions for thermal expansion. Install so as to prevent leakage of flue gases into the building. Provide drain connections where condensate is likely to accumulate, and pipe to spill over floor drain.

4. Provide ventilated thimbles where vents pass through walls, floors and roof. Paint all galvanized or aluminized steel parts exposed to the weather with one coat of corrosion and heat-resistant primer, and one coat of heat resistant paint.

5. Terminate low heat appliances as indicated on the drawings, but not less than:

   a. 3 ft above the highest point where the vent passes the roof.

   b. 2 ft above any portion of a building within a horizontal distance of 10 ft.

   c. 3 ft above any forced air inlet located within 10 ft.

B. Type IV: Install per the drawings and these specifications, per manufacturer's instructions, per the terms of the vent's UL listing, and per NFPA-211.

3.4 DAMPERS FOR FIRE AND SMOKE CONTROL

A. Select FDs, SMDs and FSDs as appropriate to the application. Dampers may be rectangular or round, and single-section or multi-section as required, but shall not be less than the duct sizes indicated on the drawings nor larger than the maximum sizes per the UL listing for a given style of damper. Provide transitions and sleeves as required.

1. FSDs may be used where SMDs are indicated provided they meet the required ratings of the indicated SMDs and provided the FSDs are installed in accordance with their listing.

B. Install dampers in accordance with their listing. Terminate acoustic lining at dampers as necessary to ensure proper damper operation. Install actuators and access doors on the side of the duct unless space conditions preclude this. Provide adequate clearance for proper operation, and minimum 36-inch clearance for servicing actuator.

1. When space conditions preclude installing actuators on the side, such components may be installed on the top or bottom of the duct provided good access to these components is maintained.

2. When size requires the use of multiple dampers, provide framing to ensure the dampers remain in place.

3. Provide a duct access door at each FD, SMD and FSD for inspection and maintenance. Provide minimum 1/2-inch high label, "SMOKE DAMPER," "FIRE DAMPER," or "FIRE/SMOKE DAMPER."

C. Test all SMDs and FSDs after the system is installed to ensure proper operation based on both smoke and fire signals. Advise Owner minimum 2 weeks in advance and invite him to observe these tests. Submit a written report with a table which identifies each such damper (along with plans which indicate each such damper); gives its size, type and model number; the date on which it was tested; the test results; and places for the initials of the person performing test for the contractor and the person witnessing test for owner. Should any dampers fail to operate properly, service them and demonstrate proper operation. Reset all dampers when the testing is complete.

3.5 FILTERS AND FILTER GAUGES

A. Provide one set of MERV-7 temporary filters until testing and balancing is complete. Then immediately before the system is turned over to the Owner at the completion of the project, remove these filters and provide the specified filters.

3.6 GRILLES REGISTERS AND DIFFUSERS

A. Install grilles, registers & diffusers (GRDs) square with building construction. Mount sidewall GRDs minimum, 3-inches above floor level. If GRDs have provisions to adjust the direction of air flow, submit a written recommendation regarding the best direction for air flows, obtain written approval from the Owner's Representative, and adjust GRDs accordingly.

B. Verify frame types with architectural RCPs prior to ordering GRDs.

3.7 CLOSEOUT ISSUES

A. Leakage Testing

1. Pressure test not less than 25% of the installed ductwork of each system rated at 3 in wg or more, either positive or negative pressure. Advise Owner's Representative when systems will be ready for testing. For large systems separate tests may be made on different sections. The Owner's representative will designate the sections to be tested, but not more than 24 hours in advance of test. Cap ends of ducts as required and provide equipment as required for testing.

2. Measure duct leakage per the SMACNA HVAC Duct Leakage Test manual. Leakage shall not exceed the following:

   $L_{max} = C_L P^{0.65}$, where

   L_{max} = maximum permitted leakage, cfm/100 sf of duct surface area

   C_L = Duct leakage class (cfm/100 sf at 1-inch wg)

   = 6 for rectangular sheet metal, rectangular fiberglass, and round flexible ducts

   = 3 for round and flat oval sheet metal or fiberglass ducts

   P = Test pressure. Test pressure shall match system pressure class.

3. If sample is defective, the contractor shall repair or modify the defective section and re-test it to demonstrate compliance. In addition, for each section which fails its original pressure test, the Owner's Representative will designate an additional ductwork section of similar size, for the Contractor to test. This section will be in addition to 25% area originally planned to be tested. .

4. Complete all leakage testing and repairs prior to concealing ducts.

5. Submit a test report that documents the test procedure and results. Include:

   a. Test equipment – model numbers, technical data, calibration data, etc.

   b. Drawings showing the extent of the systems tested.

   c. Test results.

   d. Dates, witnesses, and signatures of witnesses.

B. Testing and Balancing: Test and balance the complete air tempering system as specified in Section 23 0593. It is anticipated that the TAB effort will identify some system deficiencies. Work in a cooperative manner to identify the cause of these deficiencies. Where deficiencies aer due to defects in installation, or workmanship, repair as required and re-test to demonstrate proper performance.

C. Cleaning

1. All ducts, coils, housing, registers, grilles, fans, etc., shall be clean when installed and shall be kept clean until the system is completed. As the various parts of the system are installed, they shall be wiped or blown clean and openings taped dust-tight with heavy paper or cardboard until the system is completed and ready for testing. At that time all covers and protective wrappings shall be removed. Where one has been torn or previously removed, the duct, coil, register, etc., shall be carefully cleaned of any dirt or dust that has entered the opening.

END OF SECTION 23 3000

SECTION 23 3423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Utility set fans.

2. Centrifugal roof ventilators.

3. Axial roof ventilators.

4. Centrifugal wall ventilators.

5. In-line centrifugal fans.

6. Propeller fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base air ratings on actual site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

1. Certified fan performance curves with system operating conditions indicated.

2. Certified fan sound-power ratings.

3. Motor ratings and electrical characteristics, plus motor and electrical accessories.

4. Material gages and finishes, including color charts.

5. Dampers, including housings, linkages, and operators.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Coordination Drawings: Show roof penetration requirements and reflected ceiling plans drawn to scale and coordinating roof penetrations and units mounted above ceiling. Show the following:

1. Roof framing and support members relative to duct penetrations.

2. Ceiling suspension assembly members.

3. Size and location of initial access modules for acoustical tile.

4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

D. Maintenance Data: For power ventilators to include in maintenance manuals specified in Division 1.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following, OAE:

1. ACME

2. Cook, Loren Company

3. Penn Ventilation Companies, Inc.

4. Greenheck Fan Corp.

2.2 UTILITY SET FANS

A. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.

B. Housing: Fabricated of steel with side sheets fastened with a deep lock seam or welded to scroll sheets.

1. Housing Discharge Arrangement: Adjustable to eight standard positions.

C. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.

1. Blade Materials: Steel.

2. Blade Type: Backward inclined.

D. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

E. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, L_{50} of 200,000 hours.

F. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor: 1.5.

2. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with motors larger than 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.

3. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

4. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

G. Accessories:

1. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades and felt edges in steel frame installed on fan discharge.

2. Access Doors: Gasketed doors with latch-type handles.

3. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.

4. Inlet Screens: Removable wire mesh.

5. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.

6. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.

2.3 CENTRIFUGAL ROOF VENTILATORS

A. Description: Belt-driven or direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Housing: Removable, galvanized steel, mushroom-domed top; square, one-piece, aluminum base with venturi inlet cone.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

3. Pulleys: Cast-iron, adjustable-pitch motor pulley.

4. Fan and motor isolated from exhaust airstream.

E. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.

3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.

2. Overall Height: 12 inches.

3. Sound Curb: Curb with sound-absorbing insulation matrix.

4. Pitch Mounting: Manufacture curb for roof slope.

5. Metal Liner: Galvanized steel.

6. Hinged Sub-base: Galvanized steel hinged arrangement permitting service and maintenance.

7. Mounting Pedestal: Galvanized steel with removable access panel.

8. Sound Curb: Curb with sound-absorbing insulation matrix.

9. Pitch Mounting: Manufacture curb for roof slope.

10. Metal Liner: Galvanized steel.

11. Hinged Sub-base: Galvanized steel hinged arrangement permitting service and maintenance.

12. Mounting Pedestal: Galvanized steel with removable access panel.

2.4 CENTRIFUGAL WALL VENTILATORS

A. Description: Belt-driven or direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.

B. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; venturi inlet cone.

C. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

3. Pulleys: Cast-iron, adjustable-pitch motor pulley.

4. Fan and motor isolated from exhaust airstream.

E. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through internal aluminum conduit.

2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.

3. Wall Grille: Ring type for flush mounting.

4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in wall sleeve; factory set to close when fan stops.

2.5 IN-LINE CENTRIFUGAL FANS

A. Description: In-line, belt-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.

B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct-Driven Units: Motor encased in housing outside of airstream, factory wired to disconnect switch located on outside of fan housing.

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

F. Accessories:

1. Companion Flanges: For inlet and outlet duct connections.

2. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.

3. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.6 PROPELLER FANS

A. Description: Belt-driven or direct-driven propeller fans consisting of fan blades, hub, housing, orifice ring, motor, drive assembly, and accessories.

B. Housing: Galvanized steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

C. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.

D. Fan Wheel: Replaceable, extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades, may be used.

E. Belt-Driven Drive Assembly: Resiliently mounted to housing, statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor: 1.4.

2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
   a. Ball-Bearing Rating Life: ABMA 9, L_{10} of 100,000 hours.

4. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.

5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with motors larger than 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.

6. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

7. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

F. Accessories:

1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.

2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.

3. Wall Sleeve: Galvanized steel to match fan and accessory size.

4. Weathershield Hood: Galvanized steel to match fan and accessory size.

5. Weathershield Front Guard: Galvanized steel with expanded metal screen.

6. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to less than 50 percent.

7. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, or on approved surface in sight of fan.

2.7 MOTORS

A. Comply with requirements in Division 23 Section "Motors."

B. Enclosure Type: Guarded dripproof.

2.8 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support units using spring isolators having a static deflection of 1 inch. Vibration- and seismic-control devices are specified in Division 23 Sections.

1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

C. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

D. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 7 Section "Roof Accessories" for installation of roof curbs.

E. Support suspended units from structure using threaded steel rods and spring hangers. Vibration-control devices are specified in Division 23 Sections.

1. In seismic zones, restrain support units.

F. Install units with clearances for service and maintenance.

G. Label units according to requirements specified in Division 23 Section "Mechanical Identification."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment.

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Equipment Startup Checks:

1. Verify that shipping, blocking, and bracing are removed.

2. Verify that unit is secure on mountings and supporting devices and that connection to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.

3. Verify that cleaning and adjusting are complete.

4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.

5. Verify lubrication for bearings and other moving parts.

6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

7. Disable automatic temperature-control operators.

8. Verify that isolation dampers shut tightly when units are "off," and open fully when units are "on."

B. Starting Procedures:

1. Energize motor and adjust fan to indicated rpm.

2. Measure and record motor voltage and amperage.

C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Shut unit down and reconnect automatic temperature-control operators.

F. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

G. Replace fan and motor pulleys as required to achieve design airflow.

H. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

3.5 CLEANING

A. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

B. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain power ventilators.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.

2. Review data in maintenance manuals. Refer to Division 1 Section "Closeout Procedures."

3. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."

4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 23 3423

SECTION 23 3713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

B. Related Sections include the following:

1. Division 23 Section 23 3000 "Air Tempering System and Equipment" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

2. See special notes and requirements on Division 23 Drawings.

1.3 SUBMITTALS

A. Product Data: For each product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension assembly members.

2. Method of attaching hangers to building structure.

3. Size and location of initial access modules for acoustical tile.

4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

5. Duct access panels.

C. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.

D. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.

PART 2 - PRODUCTS

2.1 GENERAL

A. Grilles, registers and diffusers shall be fabricated of steel or aluminum. Aluminum only shall be used in areas of high moisture content. Steel grilles, diffusers and registers shall receive a zinc phosphate prime coat and a baked white enamel finish. Aluminum grilles, diffusers and registers shall also be finished in baked white enamel. The type of grille, diffuser, or register is shown by symbol number on the drawings. All symbol numbers shall be crosschecked against the architectural room finish schedule, which shall govern in the event of conflict; discrepancies shall be clearly noted on the submittals. Furnish additional T-bars as required to support and finish around ceiling mounted diffusers and grilles. Equipment manufactured by Metalaire, Krueger, or Titus. Ductwork runouts connecting diffusers with round necks shall be the same size as the diffuser neck, unless otherwise noted. All grilles, registers and diffusers shall be ADC (Air Diffusion Council) certified and rated in accordance with the ADC equipment test code.

2.2 DIFFUSERS, GRILLES AND REGISTERS

- DVD-1 Description: Furnish and install Price model series DF1R (WxH) (or approved equal) with the configurations and mounting types indicated on the plans and air outlet schedule.
- Performance: Air shall be delivered to the space at low noise levels and low velocities that are even across the diffuser face, in all ducting configurations and without the use of nozzles. Diffuser Manufacturer shall provide sound and pressure drop data derived from tests in accordance with ASHRAE Standard 70-2006.Performance data for Draft Rate (%DR) shall be provided based on tests in accordance with ASHRAE Standard 55-2004. A software program that allows room comfort evaluation for specific operating conditions and diffuser locations shall be available to aid in performance assessment. If such a computer program is not available from the manufacturer, the manufacturer shall supply, free of charge, a CFD model of the representative spaces completed by a modeling contractor who has demonstrable qualifications to model such spaces. These shall include no less than 10 years of experience in the modeling of displacement ventilation systems, thorough validation of the code through comparison to empirical data as well as a list of references.
- Construction: The 1-way flat faced recessed displacement diffuser, model DF1R, shall be constructed with an equalization baffle behind the operative diffuser face for uniform, low velocity, distribution of supply air. Both the equalization baffle and face shall be securely retained in the diffuser frames. Plastic nozzle arrays or any plastic components are unacceptable. There shall be no visible fasteners on the front panel. The operative face shall be constructed of painted 16 gauge perforated steel. The installation frame shall be constructed of 24 gage steel. The internal baffling elements shall be constructed of aluminum. The paint shall be powder coat polyester. Epoxies and their derivatives are unacceptable. Visible non-metallic components are unacceptable. The diffuser shall be supplied with an installation frame for recessed installation that is not visible from the

room. (The diffuser shall be supplied with an installation frame for recessed installation which allows the diffuser to be installed in areas where plaster is required).

- E. Mounting/Fastening: The diffuser shall be installed within the supplied installation frame. The diffuser shall have no visible fasteners or framing, and shall be held within the supplied installation frame via secure mounting clips.
- DVD-2 Description: Furnish and install Price model series DF1 (WxH) (or approved equal) with the configurations and mounting types indicated on the plans and air outlet schedule.
- Performance: Air shall be delivered to the space at low noise levels and low velocities that are even across the diffuser face, in all ducting configurations and without the use of nozzles. Diffuser Manufacturer shall provide sound and pressure drop data derived from tests in accordance with ASHRAE Standard 70-2006.Performance data for Draft Rate (%DR) shall be provided based on tests in accordance with ASHRAE Standard 55-2004. A software program that allows room comfort evaluation for specific operating conditions and diffuser locations shall be available to aid in performance assessment. If such a computer program is not available from the manufacturer, the manufacturer shall supply, free of charge, a CFD model of the representative spaces completed by a modeling contractor who has demonstrable qualifications to model such spaces. These shall include no less than 10 years of experience in the modeling of displacement ventilation systems, thorough validation of the code through comparison to empirical data as well as a list of references.
- Construction: The 1 way flat faced Displacement diffuser, model DF1 shall be constructed with an equalization baffle behind the operative diffuser face for uniform, low velocity, distribution of supply air. Both the equalization baffle and face shall be securely retained in the diffuser frames. Plastic nozzle arrays or any plastic components are unacceptable. The diffuser frames shall be constructed of high strength aluminum extrusion for rigidity and protection of the operative face and side panels. There shall be no visible fasteners on the front or side panels. The operative face shall be constructed of painted 16 gauge perforated steel, rear side and end panels shall beprovided in painted 20 gauge steel. The frame andinternal baffling elements shall be constructed ofAluminum. The diffuser shall be available for ductconnection at the top, bottom, side or rear of the diffuser with a factory or field cut inlet. The paint shallbe powder coat polyester. Epoxies and their derivatives are unacceptable. Visible non-metallic componentsare unacceptable. The diffuser shall be supplied with a rail mounting system that does not requirepuncturing the diffuser to install. Mounting/Fastening: The diffuser shall fasten to the wall via a rail mounting system. The rail mounting system with metal cover strips to conceal all visible fasteners.
- SD-1 Ceiling Supply Diffuser: Stamped face, Lay-in ceiling, round neck with adjustable tabs, fixed louvers, and baked white enamel finish. Price SCD or equivalent. T-Bar mount, SCD, Type 3.
- SD-2 Ceiling Supply Diffuser: Stamped face, fixed ceiling, round neck with adjustable tabs, fixed louvers, volume regulator, baked white enamel finish. Price SCD, or equivalent. Surface mount, SCD, Type 31.
- SD-3 Ceiling Supply Diffuser: Stamped face, Lay-in ceiling, round neck with adjustable tabs, fixed louvers, and baked white enamel finish. Price SCD or equivalent. T-Bar mount, SCD, Type 3.
- SD-4 Ceiling Supply Diffuser: Stamped face, fixed ceiling, round neck with adjustable tabs, fixed louvers, volume regulator, baked white enamel finish. Price SCD, or equivalent. Surface mount, SCD, Type 31.
- SR-1 Sidewall Supply Register: Double deflection type with horizontal face bars and

opposed blade damper with removable key operator, 1-1/4" flat margin, 3/4" bar spacing, baked white enamel finish, aluminum or steel, and sized as shown on the drawings. Price 520D, or equivalent.

- EG-1 Ceiling Exhaust Register: Aluminum core of 1/2" x 1/2" x 1/2" squares in 3/16" aluminum or steel frame for use in exposed tee bar ceiling with white aluminum finish, sized as shown on the drawings. Price 80, or equivalent.
- EG-2 Ceiling Exhaust Register: Aluminum core of 1/2" x 1/2" x 1/2" squares in flat aluminum frame with approximately 1-1/2" margin for surface mounting with white aluminum finish, and opposed blade damper. Sized as shown on drawings. Price 80D with damper, or equivalent.
- ER-1 Sidewall Exhaust Register: Fixed horizontal bars on 3/4" centers set at 45 degrees, approximately 1-1/4" margin, opposed blade damper, baked white enamel finish, and sized as shown on the drawings. Price 530D, or equivalent.
- RG-1 Ceiling Return Grille: Aluminum core of 1/2" x 1/2" x 1/2" squares in flat aluminum frame with approximately 1-1/4" margin for surface or lay-in mounting. Sized as shown on drawings. Price 80 or equivalent.
- RR-1 Sidewall Return Air or Transfer Grille: Fixed horizontal bars on 3/4" centers set at 45 degrees, approximately 1-1/4" margin, no opposed blade damper, baked white enamel finish, furnish grille on each exposed wall surface, and sized as shown on the drawings. Price 530, or equivalent.
- SS-1 Linear Supply Diffuser: Extruded aluminum construction with baked white enamel frame suitable for lay-in or surface mounting to gypboard (ceiling and sidewall). Surface mounted type shall have minimum 1-1/8" borders with frame mounting holes. Interior surfaces shall be finished in dull black. Diffusers shall have a fully adjustable air pattern with flow control vanes that shall be capable of deflecting the air pattern from horizontal to vertical or at intermediate settings. Each diffuser shall have a self-aligning device (where length is greater than four feet) resulting in perfect alignment without being visible. See plans for actual cfm, diffuser length, type of ceiling, and number of 1" slots. Price SDA100 or equivalent. Provide linear slot sheet metal plenum.
- RS-1 Linear Return: Extruded aluminum construction with baked white enamel frame suitable for lay-in or surface mounting to gypboard (ceiling and sidewall). Surface mounted type shall have minimum 1-1/8" borders with frame mounting holes. Interior surfaces shall be finished in dull black. Each linear return shall have a self-aligning device (where length is greater than four feet) resulting in perfect alignment without being visible. See schedule and plans for actual cfm, for length, type of ceiling, and number of 1" slots. Price SDR-8 SLOT or equivalent.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 3713

SECTION 23 3813 - KITCHEN EXHAUST AND MAKEUP AIR SYSTEMS

PART 1 GENERAL

1.1 REQUIREMENTS

A. Conform to applicable provisions of the General Conditions, Special Conditions and General Requirements.

B. Comply with all requirements specified in Section 23 30 00, and see that section for components and installation requirements not specified in this Section.

C. See also Sections 23 0500, 23 0548, 23 0549, 23 0593, 23 0700, and 23 0900 for related work.

1.2 SCOPE

A. Provide all equipment, sheetmetal, and HVAC system components indicated on the drawings and specified herein for complete and functional HVAC systems to serve the kitchen. This section includes those components that are unique to the kitchen makeup and exhaust air systems. Certain components are specified in Section 23 30 00.

B. Rough-in and connect to kitchen hoods supplied and/or installed by others.

1.3 SUBMITTALS

A. Submit the following for review and approval:

1. All equipment shown on the equipment schedule and/or specified herein.

2. Ductwork construction standards, accessories, and layouts. Layouts shall be at a scale appropriate for the areas shown, but not less than 3/8-inch = 1’-0”. Include large scale sections as appropriate.

1.4 QUALITY ASSURANCE

A. Comply with UMC-2006 Chapter 5 Articles 5.07 through 5.17.

B. Comply with NFPA-96.

C. Fire extinguishing systems shall be installed by persons trained and qualified to install the specific system provided.

1.5 DEFINITIONS

A. Type 1 Hood: A kitchen hood for collecting and removing grease and smoke.

B. Type 2 Hood: A kitchen hood for collecting and removing steam, vapors, heat or odors.

PART 2 PRODUCTS

2.1 MAKEUP AIR UNITS

A. Rooftop Direct-Fired/Evap Cooled

1. General: Factory fabricated, packaged rooftop, direct-fired with evap cooling, ETL Listed to ASNI Z83.4-1999, factory wired and tested (gas train, electrical components and air flow controls).

2. Unit Construction: Heavy gauge G90 galvanized steel casing with corrosion resistant fasteners, weatherproof with standing seam where roof panels are joined, all metal-to-metal surfaces sealed where exposed to the weather, 1-inch fiberglass insulation, discharge configuration as indicated on drawings, access doors or removable panels for ready access to all components, and lifting lugs.

3. Heating Section: Direct fired with cast aluminum burner, for use with natural gas at 900 – 1000 Btu/SCF HHV, SS mixing plates, Maxitrol or equivalent controls with 25:1 turndown, IRI or FM gas train, and all necessary safety and operating controls..

4. Cooling Section: Evaporative type, SS module construction, 12-inch media with 90% cooling effectiveness, with float-type makeup, 120V pump with discharge piping and corrosion-resistant distribution header, drain & overflow connections.

5. Fan Section: AMCA rated for both performance and sound, centrifugal type statically and dynamically balanced, permanently lubricated bearings with 100,000 Hr L-10 life at maximum cataloged speed, belt driven with drive sized for 150% of motor HP, pulleys with machined surfaces, adjustable sheaves for 15 Hp and less, motor per Spec Section 23 05 00, fan discharge flexible connection, and with fan and motor mounted on common base.

6. Electrical and Controls: Factory wired for service from a single-point power connection, with all necessary power and control components mounted in accessible and weather-protected enclosures, all wiring per the NEC, control transformer with secondary fusing, contacts for remote start/stop and monitoring of fan status, and discharge temperature sensor with all components necessary for discharge temperature control. All components UL listed, recognized or classified where applicable.

7. Accessories: double wall construction, motorized intake damper, 2-inch aluminum mesh filters sized for less than 550 FPM, dirty filter switch, fan and motor base spring isolated with minimum 1-inch static deflection, discharge fan configuration as shown on drawings, inlet weather hood with bird screen, louvered inlet with bird screen, minimum 12-inch insulated roof curb of G90 galvanized steel, evaporative cooler media with Class II rating per UL 900 (e.g., GLASdek), automatic blowdown controls (timed blowdown is acceptable), disconnect switch, fan motor starter, premium efficiency motor, and 115V convenience receptacle in NEMA 3R enclosure.

a. Variable Volume: Class F motor insulation and automatic burner bypass damper (may be self-adjusting) to ensure proper burner operation under the full range of operating conditions.

8. Approved Manufacturers: Captive Aire, Greenheck Model DGX, Spec Air, or approved equal.

2.2 EXHAUST FANS

A. Centrifugal Roof Exhaust Type:

1. Factory fabricated fan, motor, drive, and accessories specifically designed for kitchen hood exhaust applications. Leakproof construction, listed for grease removal per UL 762, with air and sound data listed per

a. Housing: Spun aluminum construction, vertical discharge, reinforced wind band welded to one-piece curb cap with mounting holes on the side and integral spun venturi, spun aluminum motor compartment with readily removable cover and breather tube. All other structural components shall be galvanized steel.

b. Fan wheel: Backward inclined, centrifugal, non-overloading, statically & dynamically balanced, with shaft sized so first critical speed is minimum 25% above maximum operating speed.

c. Motor and drive: Premium efficiency ODP motor per Spec Section 23 05 00, out of the air stream, cooled with ambient air, direct drive or belt driven as indicated in schedule on drawings, bearings with 100,000 hr L-10 life. Motor, drive and fan wheel resiliently mounted on neoprene isolators.

1) Variable Speed Applications: Provide Class F insulation.

d. Belt Drive: Adjustable pitch sheave up to 5 Hp, fixed pitch above this HP, cast and machined pulleys with all components sized for 150% of motor Hp.

e. Electrical: Disconnect (NEMA-1 if protected from the weather, or NEMA-3R if exposed to the weather) wired to motor, with all wiring and components per NEC and either UL Listed or UL recognized.

f. Accessories: Stamped aluminum nameplate, hinge kit to allow tilting fan up to inspect wheel, retaining chains, grease trap with absorbent material, drain trough which can be piped either to a roof-mounted grease collector, or can be piped back to the hood, conduit chase and roof curb.

1) Roof Curb: Minimum 24-inch galvanized steel, fiberglass insulated, with wood nailer, and flange. Provide cant and step if needed for proper seal with roof. Provide ventilated extension curb so exhaust duct extends minimum 18-inches above roof deck, and so fan discharges minimum 40-inches above roof deck.

g. Approved Manufacturers: Captive Aire, Greenheck CUE or CUBE, Cook, or approved equal.

2.3 DUCTWORK

A. Makeup Air System: Galvanized steel per Section 23 3000.

B. Type 1 Hood Exhaust Systems

1. Ductwork and Supports: Minimum 16-gauge carbon steel or 18-guage SS.

2. Access Panels: Minimum 16 gauge steel with latching mechanism or bolted door fasteners, grease-tight, UL Listed for installation into grease duct, with temperature resistant gasket and sealant. Acudor, Flame Guard, or equal.

3. Alternate: A UL Listed, double wall grease duct system may be used in lieu of a welded system as specified here. All fittings and joints shall be supplied by the Manufacturer. Provide all necessary cleanouts, drains, etc. Approved manufacturers: Metal Fab, Metalbestos Schebler, DAE.

C. Stainless Steel Ductwork: Provided 304 SS ductwork for moisture-laden exhaust air streams (e.g., dishwashers) 18 gauge No. 2B finish where ducts are exposed, with continuously welded joints, liquid-tight. Where seams are located on bottom surface or within 1.5-inches of bottom surface, continuously weld seams liquid-tight.

PART 3 EXECUTION

3.1 MAKEUP AIR UNITS

A. Install roof curb as per Spec Section 23 30 00 and install MAU onto curb. Install gas piping, water and drainage piping, discharge ductwork, and controls.

B. Start up unit. Have manufacturer's representative confirm proper system operation and submit startup report.

C. Demonstrate proper system operation to the owner's representative, including:

1. That MAU and exhaust fans energize together based on kitchen hood switch.

2. That motorized isolation damper opens when unit is energized and shuts when unit is off.

3. That discharge temperature controls properly modulate heating control and cycle evaporative cooler pump to maintain discharge temperature setpoint

4. That evaporative cooler makeup and blowdown systems function properly

5. That evaporative cooler shutoff valve and drain valve are conveniently located along a wall approximately 5 ft above grade, and that all piping subject to freezing can be readily and completely drained into a floor drain or floor sink to prevent freezing, without draining onto the floor.

3.2 EXHAUST FANS

A. Install roof curb as per Spec Section 23 30 00, and install fan onto curb. Connect ductwork per fan manufacturer's recommendations and per UMC Section 511.

3.3 DUCTWORK

A. General:

1. Comply with the requirements specified in Section 23 30 00 and UMC Sections 507 – 517.

2. Install without forming dips or traps which might collect residue

3. Lowest end of main duct shall be flush on the bottom with branch duct.

B. Exhaust Ductwork for Type I Hoods

1. Install ductwork, insulation, grease removal devices, fans, etc, so as to maintain required clearances from adjacent construction.

2. Materials and Thicknesses:

   a. Interior Ductwork: 16-gauge steel or 18-gauge SS

   b. Exterior Ductwork: 18 gauge SS

3. Construction:

   a. All seams, joints, penetrations, duct-to-hood collar connections, etc, shall be continuously welded and liquid-tight except as permitted by UMC Section 510.5.2.1.

   b. Install so that grease cannot become pocketed in any portion of ductwork.

   c. Telescoping or bell-type duct joints: Configure to be self-draining and per UMC Section 510.5.2.2.

   d. Slope: Minimum 1/4 inch per foot to drain toward hood or approved grease reservoir. Where horizontal length exceeds 75 ft, slope not less than 1 inch per ft.

   e. Bolts, screws, rivets and other mechanical fasteners: Shall not penetrate duct walls.

4. Dampers and flexible connectors: Do not provide in Type 1 hood exhaust systems.

5. UL Listed Grease Duct Systems: Install in accordance with their listing, and per manufacturer's recommendations.

6. Openings:

   a. Provide as required to allow proper operation, maintenance, inspection and cleaning of all sections of ductwork, and as required by code.

   b. Provide at each change in direction.

   c. Locate so as to provide unobstructed access to openings. Provide a sign on each

access panel reading, “ACCESS PANEL – DO NOT OBSTRUCT”.

d. Provide within 3 ft of fan inlet and outlet where fans have ducted connections.

e. Horizontal Ducts:

1) Provide openings large enough for cleaning. Locate not more than 12 ft on centers.

2) Where any duct crossectional dimension is 24-inches or larger, provide minimum one 20-inch x 20-inch opening for personnel entry. Provide hangers to support the weight of ductwork plus 800 lbs.

3) Install on sides or top of duct, minimum 1-1/2 inch from the bottom of the duct.

f. Vertical Ducts:

1) Where personnel entry is possible provide access door at top of riser

2) Where personnel entry is not possible, provide access door at each floor level.

7. Supports: Provide as required to support vertical and lateral loads within the stress limitations of the building code. Supports shall be of the same material as the ductwork.

8. Damage to Covering or Enclosure: Advise Owner’s Representative if any portion of ductwork, insulation or ductwork enclosure is damaged in any way, and repair so as to restore fire-resistance rating.

C. Exhaust Ductwork for Wet Applications:

1. Provide 18-gauge 304 SS ductwork for moisture-laden exhaust air streams (e.g., dishwashers) with No. 2B finish where ducts are exposed, with continuously welded joints, liquid-tight. Where seams are located on bottom surface or within 1.5-inches of bottom surface, continuously weld seams liquid-tight.

2. Welds shall be free from pits, runs, spatter and other imperfections, and ground smooth and flush with joined surfaces. Pitch horizontal ductwork downward toward intake opening. Where traps occur that collect water, provide a 3/4-inch half-coupling welded to the bottom of the duct and extended to the nearest drain.

D. Exhaust Ductwork for Type 2 Hoods in Dry Applications: Galvanized steel per Spec Section 23 3000.

3.4 CLEANING

A. Clean ductwork per Specification Section 23 3000.

END OF SECTION 23 3813

SECTION 23 5216 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes packaged, factory-fabricated and -assembled, gas-fired, fire-tube condensing boilers, trim, and accessories for generating.

1.3 ACTION SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.

a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.

2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that boiler, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Source quality-control reports.

C. Field quality-control reports.

D. Warranty: Special warranty specified in this Section.

E. Other Informational Submittals:

1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fails in materials or workmanship within specified warranty period.

1. Warranty Period for Fire-Tube Condensing Boilers:

a. Leakage and Materials: ten <10> years from date of Substantial Completion.

b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Prorated for ten <10> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FIRE-TUBE CONDENSING BOILERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Lochinvar or approved equal.

B. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.

C. Hot water boilers and associated auxiliary equipment shall be as specified on the equipment schedule on the drawings.

D. The Contractor shall furnish and install a factory assembled automatic boiler control system as specified on the Equipment Schedule on the drawings and in Section 230900 for fully automatic operation of the boiler system. Electrical power, control, and interlock wiring shall be provided as specified in Section 23 0500 and 23 0549 and Division 26, Electrical.

E. Furnish and install all devices as requested by the City of Farmington boiler inspector. Local manufacturer's representative must have minimum five (5) years experience in startup and service of boiler to be provided.

F. The BOILER shall bear the ASME "H" stamp for 160 psi working pressure and shall be National Board listed. The BOILER shall have a fully welded 316L stainless steel, fire tube heat exchanger. There shall be a single pressure vessel. Multiple pressure vessels are not acceptable. Fire Tube shall be of the Wave Fire Tube design and capable of transferring 30,000 to 40,000 Btu’s per tube. A liquid impact die shall be used to form the Wave Fire Tube. There shall be no banding material, bolts, gaskets or "O" rings in the heat exchanger construction. The Wave Fire Tube shall be robotically welded to the tube sheets. The heat exchanger shall be

designed for a single-pass water flow to limit the water side pressure drop. Pressure drop shall be no greater than 2.4 psi at 180 gpm. The condensate collection basin shall be constructed of welded 316L stainless steel. The complete heat exchanger assembly shall carry a ten (10) year limited warranty.

G. The BOILER shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.13 test standard for the U.S. and Canada. The BOILER shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard and the minimum efficiency requirements of the latest edition of the AHRI BTS-2000 Standard as defined by the Department of Energy in 10 CFR Part 431. The BOILER shall operate at a minimum of 92% thermal efficiency (FB 1500- FB 3500) or 93% thermal efficiency (FB 4000-FB 5000) at full fire as registered with AHRI. All models shall operate up to 97% thermal efficiency with return water temperatures at 90°F or below at 20°F temperature rise. The BOILER shall be certified for indoor installation.

H. The BOILER shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. Two burner/flame observation ports shall be provided. The single burner shall be a premix design with an upper and a lower chamber supplied by individual combustion systems and constructed of high temperature stainless steel with a woven Fecralloy outer covering to provide modulating firing rates. The BOILER shall be supplied with two gas valves designed with negative pressure regulation and be equipped with a pulse width modulation blower system, to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The BOILER shall operate in a safe condition with gas supply pressures as low as 4 inches of water column. The burner flame shall be ignited by direct spark ignition with flame monitoring via a flame sensor.

I. The BOILER shall utilize a 24 VAC control circuit and components. The control system shall have a display for boiler set-up, boiler status, and boiler diagnostics. All components shall be easily accessed and serviceable from the front and top of the jacket. The BOILER shall be equipped with a temperature/pressure gauge; high limit temperature control with manual reset; ASME certified pressure relief valve set for 50 psi (standard); outlet water temperature sensor (dual thermistor); return water temperature sensor; outdoor air sensor, flue temperature sensor (dual thermistor); high and low gas pressure switches, low water cut off with manual reset, blocked drain switch and a condensate trap for the heat exchanger condensate drain.

J. The BOILER shall feature the “SMART TOUCH™” control which is standard and factory installed with an 8” liquid crystal touch screen display, password security, outdoor air reset, pump delay with freeze protection, pump exercise, ramp delay featuring six steps, domestic hot water prioritization with limiting capabilities and PC port connection. A secondary control that is field mounted outside or inside the appliance is not acceptable. The BOILER shall have alarm contacts for any failure, runtime contacts and data logging of runtime at given modulation rates, ignition attempts and ignition failures. The BOILER shall have a built-in “Cascade” to sequence and rotate while maintaining modulation of up to eight boilers of different Btu inputs without utilization of an external controller. The internal “Cascade” function shall be capable of lead-lag, efficiency optimization, front-end loading, and rotation of lead boiler every 24 hours. The BOILER shall be capable of controlling an isolation valve (valve shall be offered by manufacturer) during heating operation and rotation of open valves in standby operation for full flow applications. The control must be equipped with standard Modbus communication protocol

with a minimum 55 readable points. The BOILER shall have an optional gateway device which will allow integration with LON or BacNet (MSTP or IP) protocols.

K. The "SMART TOUCH™" control shall increase fan speed to boost flame signal when a weak flame signal is detected during normal operation. A 0 -10 VDC output signal shall control a variable speed boiler pump (pump to be offered by manufacturer) to keep a fixed delta t across the boiler regardless of the modulation rate. The BOILER shall have the capability to receive a 0 – 10 VDC input signal from a variable speed system pump to anticipate changes in system heat load in order to prevent flow related issues such as erratic temperature cycling.

L. The BOILER shall be equipped with two terminal strips for electrical connection. A low voltage connection board with 30 data points for safety and operating controls, i.e., Alarm Contacts, Runtime Contacts, Louver Proving Switch, Tank Thermostat, Remote Enable/Disable, System Supply Sensor, Outdoor Sensor, Tank Sensor, Modbus Building Management System signal and Cascade control circuit. A high voltage terminal strip shall be provided for Supply voltage. Supply voltage shall be 120 volt / 60 hertz / single phase on models up to 3,500,000 Btu's/Hr. Models 4,000,000 Btu's/Hr. and up shall be 208 volt / 60 hertz / three phase. The boiler may be factory trimmed for optional supply voltages, i.e. 208 volt / 60 hertz / 3 phase, 480 volt / 60 hertz / 3 phase and 600 volt / 60 hertz / 3 phase. The high voltage terminal strip plus integral relays are provided for independent pump control of the System pump, the Boiler pump and the Domestic Hot Water pump.

M. Direct Vent system with vertical and sidewall termination of both the exhaust vent and combustion air. The flue shall be Category IV approved Stainless Steel sealed vent material terminating at the rooftop with the manufacturer's specified vent termination. A separate pipe shall supply combustion air directly to the boiler from the outside. The air inlet pipe must be sealed and may be other materials listed in the Installation manual. The boiler's total combined air intake length shall not exceed 100 equivalent feet. The boiler's total combined exhaust venting length shall not exceed 100 equivalent feet. The air inlet must terminate on the rooftop with the exhaust.

N. The BOILER shall have an independent laboratory rating for Oxides of Nitrogen (NOx) to meet the requirements of South Coast Air Quality Management District in Southern California and the requirements of Texas Commission on Environmental Quality (FB 1500-FB 2000). The manufacturer shall verify proper operation of the burner, all controls and the heat exchanger by connection to water and venting for a factory fire test prior to shipping.

O. The BOILER shall operate at altitudes up to 4,500 feet above sea level without additional parts or adjustments. High altitude operation shall be certified at a minimum of 4,500 feet above sea level by a 3rd party organization.

P. Characteristics and Capacities:

1. See Schedule.

2.2 TRIM

A. Include devices sized to comply with ANSI B31.9, "Building Services Piping."

B. Aquastat Controllers: Operating, firing rate, and high limit.

C. Safety Relief Valve: ASME rated.

D. Pressure and Temperature Gage: Minimum 3-1/2-inch- (89-mm-) diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.

E. Boiler Air Vent: Automatic.

F. Drain Valve: Minimum NPS 3/4 (DN 20) hose-end gate valve.

G. Circulation Pump: Non-overloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

2.3 CONTROLS

A. Refer to Section 230900 "Instrumentation and Control for HVAC."

B. Boiler operating controls shall include the following devices and features:

1. Control transformer.

2. Set-Point Adjust: Set points shall be adjustable.

3. Operating Pressure Control: Factory wired and mounted to cycle burner.

4. Low-Water Cutoff and Pump Control: Cycle feedwater pump(s) for makeup water control.

5. High Cutoff: [Manual] [Automatic] reset stops burner if operating conditions rise above maximum boiler design [temperature] [pressure].

6. Low-Water Cutoff Switch: [Electronic] [Float and electronic] probe shall prevent burner operation on low water. Cutoff switch shall be [manual] [automatic]-reset type.

7. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.

8. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

C. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.

1. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

2.4 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

1. House in NEMA 250, Type 1 enclosure.

2. Wiring shall be numbered and color-coded to match wiring diagram.

3. Install factory wiring outside of an enclosure in a metal raceway.

4. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.

5. Provide each motor with overcurrent protection.

2.5 VENTING KITS

A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.

B. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

2.6 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

A. Equipment Mounting:

1. Install boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Install gas-fired boilers according to NFPA 54.

C. Assemble and install boiler trim.

D. Install electrical devices furnished with boiler but not specified to be factory mounted.

E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 232116 Hydronic Piping Specialties."

E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

G. Install piping from safety relief valves to nearest floor drain.

H. Boiler Venting:

1. Install flue venting kit and combustion-air intake.

2. Connect full size to boiler connections.

I. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

J. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform installation and startup checks according to manufacturer's written instructions.

2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.

3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.

b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

F. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

G. Performance Tests:

1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.

2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.

3. Perform field performance tests to determine capacity and efficiency of boilers.

   a. Test for full capacity.

   b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.

4. Repeat tests until results comply with requirements indicated.

5. Provide analysis equipment required to determine performance.

6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.

7. Notify Architect in advance of test dates.

8. Document test results in a report and submit to Architect.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 23 5216

SECTION 23 7313 - MODULAR MULTIZONE INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 RELATED SECTIONS

A. Section 23 0500, Common Work Requirements for HVAC.

B. Section 23 0504, Pipe and Pipe Fittings.

C. Section 23 0505, Piping Specialties.

D. Section 23 0523, Valves.

E. Section 23 0700, HVAC Insulation.

F. Section 23 0900, Facility Management System, for temperature control valves, meters and instrumentation.

G. Division 26, Electrical.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of L/100 where "L" is the unsupported span length within completed casings.

C. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined according to ASCE/SEI.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.

2. Support location, type, and weight.

3. Field measurements.

B. Seismic Qualification Certificates: For air-handling units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source quality-control reports.

D. Field quality-control reports.

1.5 ACTION SUBMITTALS

A. Product Data: For each air-handling unit indicated.

1. Unit dimensions and weight.

2. Cabinet material, metal thickness, finishes, insulation, and accessories.

3. Fans:

a. Certified fan-performance curves with system operating conditions indicated.

b. Certified fan-sound power ratings.

c. Fan construction and accessories.

d. Motor ratings, electrical characteristics, and motor accessories.

4. Certified coil-performance ratings with system operating conditions indicated.

5. Dampers, including housings, linkages, and operators.

6. Filters with performance characteristics.

7. AHU manufacturer shall provide the following information with each shop drawing/product data submission:

8. Dimensioned arrangement drawings for each AHU including a plan and elevation view of the assembled unit with overall dimensions, lift points, unit shipping split locations and dimensions, installation and operating weights, and installation, operation and service clearances.

9. All electrical, piping, and ductwork requirements, including sizes, connection locations, and connection method recommendations.

10. Each component of the unit shall be identified and mechanical specifications shall be provided for unit and accessories describing construction, components, and options.

11. All performance data, including capacities and airside and waterside pressure drops, for components.

12. Fan curves shall be provided for fans with the design operating points indicated. Data shall be corrected to actual operating conditions, temperatures, and altitudes.

13. For units with multiple fans, a fan curve shall be provided showing the performance of the entire bank of fans at design conditions. In addition, a fan curve shall be provided showing the performance of each individual fan in the bank of fans at design conditions. Finally, a fan curve shall be provide showing the performance of the bank of fans when one fan is down. The percent redundancy of the bank of fans with one fan down shall be noted on the fan curve or in the tabulated fan data.

14. A filter schedule must be provided for each air handling unit supplied by the air handling unit manufacturer. Schedule shall detail unit tag, unit size, corresponding filter section location within the AHU, filter arrangement (e.g. angled/flat), filter depth, filter type (e.g. pleated media), MERV rating, and filter quantity and size.

15. A schedule detailing necessary trap height shall be provided for each air handling unit. Schedule shall detail unit tag, unit size, appropriate trap schematic with recommended trap dimensions, and unit supplied base rail height. Contractor shall be responsible for additional trap height required for trapping and insulation beyond the unit supplied base rail height by adequate housekeeping pad.

16. The AHU manufacturer shall provide appropriate sets of submittals as referenced in the General Conditions and shall submit to the Owner electronic copies of the IOM.

17. The AHU manufacturer shall list any exceptions to the specification.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: Two <2> set(s) for each air-handling unit.

2. Gaskets: One <1> set(s) for each access door.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. Comply with NFPA 70.

G. AMCA Publication 99 – Standards Handbook.

H. AMCA Publication 611 – Certified Ratings Program – Airflow Measurement Performance

I. AMCA Standard 500-D – Laboratory Methods of Testing Dampers for Rating.

J. ANSI/ABMA Standard 9 - Load Ratings and Fatigue Life for Ball Bearings.

K. ANSI/AMCA Standard 204 – Balance Quality and Vibration Levels for Fans.

L. ANSI/AHRI Standard 410 - Forced Circulation Air-Cooling and Air-Heating Coils.

M. ANSI/AHRI Standard 430 - Central Station Air Handling Units.

N. ANSI/UL 900 – Standard for Safety Air Filter Units.

O. AHRI Standard 260 – Sound rating of Ducted Air Moving and Conditioning Equipment.

P. ASHRAE Standard 84 - Method of Testing Air-to-Air Heat Exchangers.

Q. ASHRAE Standard 111 – Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.

R. ASTM B117 - Standard Practice for Operation Salt Spray Apparatus.

S. ASTM E477 – Standard Test Method for Measure Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.

T. NFPA 70 – National Electrical Code®.

U. NFPA 90A – Standard for the Installation of Air Conditioning and Ventilation Systems.

V. UL 1995 – Standard for Safety Heating and Cooling Equipment

W. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with current AHRI Standard 410.

X. Air handling units with fan sections utilizing single fans shall be rated and certified in accordance with AHRI Standard 430.

Y. Air handling units with fan sections utilizing multiple fans shall be rated in accordance with AHRI Standard 430 for airflow, static pressure, and fan speed performance.

Z. Airflow monitoring station: Certify airflow measurement station performance in accordance with AMCA 611.

AA. ISO 9001 Certification.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.10 REGULATORY REQUIREMENTS

A. Agency Listings/Certification

B. Unit shall be manufactured to conform to UL 1995 and shall be listed by UL. Units shall be provided with listing agency label affixed to the unit. In the event the unit is not UL approved, the contractor shall, at his/her expense, provide for a field inspection by a UL representative to verify conformance. If necessary, contractor shall perform modifications to the unit to comply with UL as directed by the representative, at no additional expense to the owner.

C. Certify air handling units in accordance with AHRI Standard 430. Units shall be provided with certification label affixed to the unit. If air handling units are not certified in accordance with AHRI Standard 430, contractor shall be responsible for expenses associated with testing of units after installation to verify performance of fan(s). Any costs incurred to adjust fans to meet scheduled capacities shall be the sole responsibility of the contractor.

D. Certify air handling coils in accordance with AHRI Standard 410. Units shall be provided with certification label affixed to the unit. If air handling coils are not certified in accordance with

AHRI Standard 410, contractor shall be responsible for expenses associated with testing of coils after installation to verify performance of coil(s). Any costs incurred to adjust coils to meet scheduled capacities shall be the sole responsibility of the contractor.

E. Certify airflow monitoring stations are tested for differential pressure in accordance with AMCA 611 in an AMCA registered laboratory and comply with the requirements of the AMCA Certified Ratings Program. Airflow monitoring station shall be licensed to bear the AMCA Seal.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. NOTE: Units shall be set in the fan rooms prior to enclosure of the rooms as there may be insufficient external openings large enough to accommodate each entire unit.

C. Units shall have tags and airflow arrows on each section to indicate location and orientation in direction of airflow. Shipping splits shall be clearly defined on submittal drawings. Cost associated with non-conformance to shop drawings shall be the responsibility of the manufacturer. Each section shall have lifting lugs for field rigging and final placement of AHU sections. Indoor AHUs less than 100 inches wide shall allow for forklift transport for maneuverability on jobsite.

D. Deliver units to jobsite with fan motor(s), sheave(s), and belt(s) completely assembled and mounted in units.

E. Indoor air handling units shall be shipped in a clear shrink-wrap or stretch-wrap to protect unit from in-transit rain and debris per ASHRAE 62.1 recommendations.

F. Installing contractor shall be responsible for storing AHU in a clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.12 START-UP AND OPERATING REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters in place, bearings lubricated (if applicable), condensate properly trapped, piping connections verified and leak-tested, belts aligned and tensioned, all shipping braces removed, bearing set screws torqued, and fan has been test run under observation.

1.13 WARRANTY

A. AHU manufacturer shall provide, at no additional cost, a standard parts warranty that covers a period of one year from unit start-up or 18 months from shipment, whichever occurs first. This warrants that all products are free from defects in material and workmanship and shall meet the capacities and ratings set forth in the equipment manufacturer's catalog and bulletins.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Trane Company.

2. York

2.2 GENERAL

A. Unit layout and configuration shall be as defined in project plans and schedule.

B. Modular Multizone Indoor Central Station Variable-Air-Volume Air-Handling Units.

C. Air-Handling Units shall include the following sections:

1. Air mixing section

2. Filter section with MERV 8 filters

3. Indirect Evaporative Cooling Heat Exchanger Section

4. Exhaust-Relief/Vaporizer fan section

5. Access section

6. Direct Evaporative Cooling Section with Full By-Pass Section

7. Access section

8. Preheat Hot water Coil

9. Access section

10. D/X Evaporator Coil:

11. Access section

12. Fan section (2x1 FAN array)

13. Access section for reheat hot water (coil) zones

14. Discharge Plenum with reheat hot water (coil) zones

2.3 UNIT CASINGS

A. General Fabrication Requirements for Casings:

1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.

2. Casing Joints: Sheet metal screws or pop rivets.

3. Sealing: Seal all joints with water-resistant sealant.

B. Factory Finish: Galvanized-Steel Casings: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on enamel finish, consisting of prime coat and thermosetting topcoat.

1. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2. Indoor air handling unit casing finish to meet ASTM B117 250-hour salt-spray test.

3. Air leakage shall be determined at 1.00 times maximum casing static pressure up to 8 inches w.g. Specified air leakage shall be accomplished without the use of caulk. Total estimated air leakage shall be reported for each unit in CFM, as a percentage of supply air, and as an ASHRAE 111 Leakage Class.

C. Casing Insulation and Adhesive:

1. Materials: ASTM C 1071, Type II.

2. Floor panels shall be double-wall construction and designed to support a 300-lb load during maintenance activities and shall deflect no more than 0.0042” per inch of panel span.

3. Unit casing panels shall be 2” double-wall construction, with solid galvanized exterior and solid galvanized interior, to facilitate cleaning of unit interior.

4. Location and Application: Encased between outside and inside casing.

5. Locations and Applications:

a. Section: Doors

b. Access Section: Doors.

c. Damper Section: Doors.

d. Filter Section: Doors large enough to allow periodic removal and installation of filters.

e. Mixing Section: Doors.

6. Service Light: LED 100-W vaporproof fixture with switched junction box located outside adjacent to door.

a. Locations: Fan sections, mixing section, filter section, and access sections.

D. Condensate Drain Pans:

1. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends).
    a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
    b. Depth: A minimum of 2 inches deep.
2. Integral part of floor plating.
3. Double-wall, galvanized-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
4. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
5. Minimum Connection Size: NPS 2
6. Material: Stainless Steel.
7. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

E. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

2.4 FAN, DRIVE, AND MOTOR SECTION

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.
    a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
    b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

B. Fan sections shall have a minimum of one access door located on the drive side of the unit to allow inspection and maintenance of the fan, motor, and drive components. Construct door(s) per Section 2.04.

C. Provide fans of airfoil type and class as specified on the schedule. Fan shafts shall be solid steel, coated with a rust-inhibiting coating, and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. All fans shall be statically and dynamically tested by the manufacturer for vibration and alignment as an assembly at the operating RPM to meet design specifications. Fans controlled by variable frequency drives shall be statically and dynamically tested for vibration and alignment at speeds between 25% and 100% of design RPM. If fans are not factory-tested for vibration and alignment, the contractor shall be

responsible for cost and labor associated with field balancing and certified vibration performance. Fan wheels shall be keyed to fan shafts to prevent slipping.

D. Belt-driven fans shall be provided with grease lubricated, self-aligning, anti-friction bearings selected for L-50 200,000-hour average life per ANSI/AFBMA Standard 9. Lubrication lines for both bearings shall be extended to the drive side of the AHU and rigidly attached to support bracket with zerk fittings. Lubrication lines shall be a clear, high-pressure, polymer to aid in visual inspection. If extended lubrication lines are not provided, manufacturer shall provide permanently lubricated bearing with engineering calculations for proof of bearing life.

E. All fans, including direct-drive plenum fans, shall be mounted on spring isolation bases. Internally-mounted motor shall be on the same isolation base. Fan and motor shall be internally isolated with 2-inch spring isolators. A flexible connection (e.g. canvas duct) shall be installed between fan and unit casing to ensure complete isolation. Flexible connection shall comply with NFPA 90A and UL 181 requirements.

F. Fan sections containing multiple fans shall be provided as indicated on the schedule and drawings. Each fan shall operate in parallel to each other fan in the array. The fans shall be SWSI plenum type with high efficient AF blades. Fans shall be direct-driven. Fan wheels shall be aluminum. The Hp characteristic of the fans shall be non-overloading.

G. Fan sections containing multiple fans shall be controlled using a common control signal, such as the duct static control signal, to modulate the fan speed.

H. Fan airflow measurement systems shall be provided as indicated on the schedule and drawings to measure fan airflow directly or to measure differential pressure that can be used to calculate airflow. The accuracy of the devices shall be no worse than +5 percent when operating within stable fan operating conditions. Devices shall not affect the submitted fan performance and acoustical levels. Devices that obstruct the fan inlet or outlet shall not be acceptable. Devices shall be connected to transducers with a 2-10 VDC output. Signal shall be proportional to air velocity.

I. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 0513 "Common Motor Requirements for HVAC Equipment."

1. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.

2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

4. Mount unit-mounted disconnect switches on exterior of unit.

5. Motors shall meet or exceed all NEMA Standards Publication MG 1 – 2006 requirements and comply with NEMA Premium efficiency levels when applicable. Motors shall comply with applicable requirements of NEC and shall be UL Listed.

6. Fan Motors shall be heavy duty, NEMA Premium efficient ODP, operable at 460 volt/60 Hz/3 phase, exceeding the EPAct efficiency requirements.

7. Belt-driven fan sections with single fans shall use 4-pole (1800 rpm) motors, NEMA Design B, with Class B insulation to operate continuously at 104°F (40°C) ambient without tripping of overloads.

8. Direct-driven fan sections shall use 4-pole (1800 rpm), NEMA Design B, with Class B insulation to operate continuously at 104°F (40°C) ambient without tripping of overloads.

9. Motors shall have a +/- 10 percent voltage utilization range to protect against voltage variation.

J. Variable Frequency Controllers:

1. VFDs shall be field installed. Refer to the drawings and specification section 23 0550 for additional VFD requirements.

2.5 INDIRECT/DIRECT EVAPORATIVE COOLING MODULE WITH ENERGY RECOVERY

A. System description: Provide Indoor Multi-zone VAV Air-Handling unit with factory installed indirect evaporative cooling module with energy recovery. The Stage II indirect/direct evaporative cooling section is designed to sensibly and adiabatically cool ventilation air without the use of refrigerants. It consists of a stainless steel housing and sump, an extended surface cross flow plate exchanger, vaporization fan(s), direct drive TEAO or TEFC motor(s), and direct evaporative media. The Stage II comes with the sump pump and all distribution piping, spray nozzles, bleed valve and balancing valve, and all necessary fittings.

B. Evaporative Cooling Section Sump
The evaporative cooling section sump is fabricated from 16 gauge Type 304 stainless steel. The joints are heli-arc continuously welded to insure full moisture integrity; the sump is factory leak tested and silicone caulked at time of assembly.

C. Indirect Evaporative Cooler
The indirect evaporative cooling section is designed to sensibly cool ventilation supply air without increasing the moisture content. It consists of 18 gauge 304 stainless steel housing, cross flow polymer plate heat exchanger, and exhaust air fan.

D. Heat Exchanger Core
The indirect evaporative dry plate heat exchanger is constructed of non-corrosive polymeric materials. Exchanger plate spacing is controlled by air turbulence spines and is designed to enhance heat transfer and efficiency. Primary and secondary airflow are separated by polymeric adhesives and rubber seals, primary airflow is horizontal and exhaust airflow is vertical in a cross-flow pattern. Air pressure drop shall not exceed 0.5” w.c. at rated CFM on both the supply and vaporization air streams. The exchanger is constructed in accordance with UL900, UL746C and UL94 standards and tested to meet ATSM 84 Class 1 flame spread rating and smoke development. A triple break mist eliminator is provided to prevent mist carryover from the exchanger. Plates can be acid washed to remove solids, and can be removed from the casing and replaced if damaged or extremely fouled. Indirect exchanger has a limited 10 year factory warranty against material defects and workmanship.

E. Exhaust Fan

The exhaust fan(s) is designed to minimize energy usage and to maximize efficiency. Totally enclosed fan cooled ball bearing motor is selected for belt drive and includes marine shaft coating for corrosion protection. Fan is a forward curve centrifugal type Class K with heavy duty bearings and powder coated fan assembly for corrosion protection. Fan is provided with motor starters and branch circuit protection.

F. Direct Evaporative Section

The direct evaporative section is designed to adiabatically cool, the supply air. The media is housed is a 304 stainless steel casing with removable top section for removal and servicing. A water distribution pad is placed on top of the media for even water distribution. The media is 12" deep high efficient cellulose impregnated with anti-rot solvents and rigidifying saturates and setting agents. Media contains 123 square feet of evaporative surface per cubic foot with a dry weight of 2.4 pounds per cubic foot. Maximum face velocity without water carry-over is 700 FPM.

G. Water Distribution

The re-circulation pumps for the indirect and direct sections are high volume constructed of stainless steel, 1/3 HP, 115/1/60 volt, mounted in the sump. The pump is rated for continuous duty and shall have with thermal overload protection. Piping system has unions for complete disassembly and is constructed of Copper pipe with adjustable balancing and bleed valves. Distribution piping has large 3.8" orifice, cross impingement non corrosive, non clogging nozzles designed to provide a overlap spray pattern to prevent dry spots on the exchanger surface. Unit provided with a Roberts heavy duty brass fill valve with air gap and float with ½ make up water connection, 2" drain connection and 2" overflow connection.

H. Include following Options

MERV 8 filters in stainless steel holding racks and hinged side access door.
Ruskin CD60 low leakage airfoil dampers with jackshaft and direct coupled actuators.
Ruskin AMS050 airflow monitor system to monitor the outside air intake, complete with actuator and transducer.
Discharge plenum constructed of 18 gauge galvanized steel double wall insulated panels mounted in an aluminum frame, painted on the interior and exterior, Full height access door hinged with door handles, door is double wall insulated and provides access for removal of the direct evaporative media and header.
Control panel for re-circulation pumps only with single power connection, control transformer, fuses and relay all wired to a numbered terminal strip. Panel shall be ETL labeled.

2.6 COIL SECTION

A. General Requirements for Coil Section:

1. Comply with ARI 410.

2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).

3. Coils shall not act as structural component of unit.

4. See equipment schedule for performance data

B. Coils section side panel shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit.

C. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil.

D. Coils shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.

E. Construct coil casings of galvanized steel. End supports and tube sheets shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.

F. All coils shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle shall be degreased and cleaned to remove any lubricants used in the manufacturing of the fins, or dirt that may have accumulated, in order to minimize the chance for water carryover.

G. When two or more cooling coils are stacked in the unit, an intermediate drain pan shall be installed between each coil. The intermediate drain pan shall be designed being of sufficient size to collect all condensation produced from the coil and sloped to promote positive drainage to eliminate stagnant water conditions. The intermediate drain pan shall be constructed of the same material as the primary drain pan.

H. The intermediate drain pan shall begin at the leading face of the water-producing device and be of sufficient length extending downstream to prevent condensate from passing through the air stream of the lower coil.

I. Intermediate drain pan shall include downspouts to direct condensate to the primary drain pan. The intermediate drain pan outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.

J. Direct Expansion Evaporator Coils.

1. Provide heavy duty aluminum fins mechanically bonded to copper tubes. Evaporator coil shall be inter- circuited to maintain active coil face area at part load conditions. Coil shall also utilize internally enhanced tubing for maximum efficiency.

2. Provide a thermostatic expansion valve (TXV) for each refrigerant circuit. Factory pressure and leak test coil at 300 psi.

3. Provide pitched stainless steel drain pan to assure positive drainage of condensate from the unit casing.

K. Hydronic Coils

1. Supply and return header connections shall be clearly labeled on unit exterior such that direction of coil water-flow is counter to direction of unit air-flow.

2. Coils shall be proof-tested to 300 psig and leak-tested to 200 psig air pressure under water.

3. Headers shall be constructed of round copper pipe or cast iron.

4. Tubes shall be 1/2 inch O.D., minimum tube thickness of 0.016 inch thick copper. Fins shall be aluminum.

2.7 AIR FILTRATION

A. General Requirements for Air Filtration Section:

1. Comply with NFPA 90A.

2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side (access side)

B. Provide factory-fabricated filter section of the same construction and finish as unit casings. Filter section shall have side access filter guides and access door(s) extending the full height of the casing to facilitate filter removal. Construct doors in accordance with Section 2.04. Provide fixed filter blockoffs as required to prevent air bypass around filters. Blockoffs shall not need to be removed during filter replacement. Filters to be of size and quantity required to maximize filter face area for each air handling unit.

C. Extended-Surface, Disposable Panel Filters:

1. Factory-fabricated, dry, extended-surface type.

2. Thickness: 2 inches

3. Arrestance (ASHRAE 52.1): 90

4. Merv (ASHRAE 52.2): 13 Filters.

5. Media: Pleated media filters made with 100% synthetic fibers that are continuously laminated to a supported steel-wire grid with water repellent adhesive shall be provided. Filters shall be capable of operating up to 625 fpm face velocity without loss of filter efficiency and holding capacity.

6. Mounting Frames: Welded, galvanized steel, with gaskets and fasteners, suitable for bolting together into built-up filter banks.

D. Filter Gage:

1. 3-1/2-inch diameter, diaphragm-actuated dial in metal case.

2. Vent valves.

3. Black figures on white background.

4. Front recalibration adjustment.

5. 2 percent of full-scale accuracy.

6. Range: 0- to 3.0-inch wg.

7. Accessories: Static-pressure tips with integral compression fittings, 1/4-inch aluminum tubing, and 2- or 3-way vent valves.

2.8 DAMPERS

A. Damper Operators: Comply with requirements in Section 23 0900 "Instrumentation and Control for HVAC."

B. All dampers shall be internally mounted. Dampers shall be premium ultra low leak and located as indicated on the schedule and plans. Blade arrangement (parallel or opposed) shall be provided as indicated on the schedule and drawings. Dampers shall be Ruskin CD60 double-skin airfoil design or equivalent for minimal air leakage and pressure drop. Leakage rate shall not exceed 4 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage and shall be AMCA licensed for Class 1A. All leakage testing and pressure ratings shall be based on AMCA Standard 500-D. Manufacturer shall submit brand and model of damper(s) being furnished, if not Ruskin CD60.

C. Airflow measuring stations shall be provided and located in the outside and/or return air paths as indicated on the schedule and plans to measure airflow. Airflow measuring stations shall be tested per AMCA Standard 611 and licensed to bear the AMCA Ratings Seal for airflow measurement performance. Integral control damper blades shall be provided as galvanized steel and housed in a galvanized steel frame. Leakage rate shall not exceed 4 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage.

D. The airflow measurement station shall measure up to 100 percent of the total outside air and/or return air. The airflow measurement station shall be capable of measuring down to 300 fpm. The airflow measuring device shall adjust for temperature variations. Output shall be provided from the station as a 2-10 VDC signal. Signal shall be proportional to air velocity. The accuracy of the measuring station shall be no greater than +/- 5 percent. Airflow measuring stations shall be mounted on the AHU interior.

2.9 OUTDOOR AIR SECTION

A. Provide 100% modulating economizer section fully integrated with unit return and exhaust air dampers.

B. Provide spring-return motor for outside air damper closure during unit shutdown or power interruption.

C. Provide outside air damper with integral airflow measuring station. Ruskin AMS50 or equivalent.

2.10 DISCHARGE PLENUM SECTION WITH HYDRONIC VAV REHEAT ZONE SECTION

A. Plenums shall be provided as indicated in the schedule and plans to efficiently turn air and provide acoustical attenuation. Discharge plenum opening types and sizes shall be scaled to meet pressure drop requirements scheduled and align with duct takeoffs.

B. Discharge plenum panels shall be 2 inches and include acoustical liner. The unit construction shall be fabricated from stainless steel perforated material to prevent corrosion and designed to completely encapsulate fiberglass insulation. Insulation material must be resistant to fungi in accordance with ASTM C1338.

C. Zones shall be controlled by low leak custom Ruskin blade dampers, with aluminum airfoil construction, stainless steel jambs and rubber seals.

D. All actuators for each zone damper shall be field installed and provided by controls contractor.

E. Zoned reheat coils and dampers shall be installed within main unit casing in the downflow configuration and above the discharge plenum in the upflow configuration. All heat modules shall be easily removable from unit for inspection and service. Each heat module shall be UL listed.

2.11 AIR HANDLING UNIT CONTROLS

A. The air handling unit controls shall be furnished by the FMS contractor and installed on the job site. The air handling unit manufacturer shall coordinate the FMS contractor on exact controls requirements related unit safeties and equipment stages. All controls shall comply with Specification 23 0900, Facility Management System, Project Control Diagrams, and Sequence of Operations.

B. The FMS contractor shall furnish installation shop drawings to the air handling unit manufacturer outlining all termination locations and point names. All controls shall comply with Specification 23 0900, Facility Management System, Project Control Diagrams, and Sequence of Operations.

C. The air handling unit manufacturer shall coordinate with FMS contractor on the installation of the system. Once the installation is complete, the FMS contractor shall be notified so that FMS contractor can perform factory start-up and testing of the system prior to the units being shipped to the field.

2.12 SOURCE QUALITY CONTROL

A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment Mounting: Install air-handling units level on concrete bases. Secure units to anchor bolts installed in concrete bases. Comply with requirements for concrete bases specified in Section 03 3000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

2. Install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air-handling unit to allow service and maintenance.

C. Connect piping to air-handling units with flexible connectors.

D. Connect condensate drain pans using NPS 2, ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot-Water Piping: Comply with applicable requirements in Section 23 2113 "Hydronic Piping." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.

G. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 23 3300 "Air Duct Accessories."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks.

2. Charge refrigerant coils with refrigerant and test for leaks.

3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

B. After the Mechanical Contractor has provided all water and refrigerant piping connections, ductwork connections, and field control wiring, and Electrical Contractor has provided all the

field power wiring, the Mechanical Contractor shall inspect the installation. The Mechanical Contractor and factory-authorized service representative shall then perform startup of the equipment.

1. The Control’s Contractor shall be scheduled to be at the job site at the time of the equipment start up.

2. Perform the following tests and services and submit a report outlining the results:

3. Record date, time, and person(s) performing service.

4. Lubricate all moving parts.

5. Check all motor and starter power lugs and tighten as required.

6. Verify all electrical power connections.

7. Conduct a start up inspection per the AHU manufacturer's recommendations.

8. Record fan motor voltage and amperage readings.

9. Check fan rotation and spin wheel to verify that rotation is free and does not rub or bind.

10. Check fan for excessive vibration.

11. Check V belt drive or coupling for proper alignment.

12. Check V belt drive for proper tension. Tighten the belts in accordance with the AHU manufacturer's directions. Check belt tension during the second and seventh day's operation and re-adjust belts, as may be required, to maintain proper tension as directed by the AHU manufacturer.

13. Remove all foreign loose material in ductwork leading to and from the fan and in the fan itself.

14. Disengage all shipping fasteners on vibration isolation equipment.

15. Check safety guards to insure they are properly secured.

16. Secure all access doors to the fan, the unit and the ductwork.

17. Switch electrical supply "on" and allow fan to reach full speed.

18. Physically check each fan at start up and shut down to insure no abnormal or problem conditions exist.

19. Check entering and leaving air temperatures (dry bulb and wet bulb) and simultaneously record entering and leaving hot water temperatures and flow, refrigerant pressures and temperatures, and outside air temperature.

20. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm

21. Measure and record motor electrical values for voltage and amperage.

22. Manually operate dampers from fully closed to fully open position and record fan performance.

C. Check all control sequences.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 23 7313

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NEW MEXICO
TEXAS
COLORADO

Division 26 –
Electrical

SECTION 26 0500 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General Conditions, Supplemental General Conditions, and Division 01 Specification Sections apply to all Sections of Division 26.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements of electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:

1. Submittals
2. Coordination Drawings
3. Record Documents
4. Maintenance Manuals
5. Rough-Ins
6. Electrical Installations
7. Cutting and Patching

1.3 ELECTRICAL DIVISION INDEX [Edit Index per job requirements]

A. Section 26 0500 Common Work Results for Electrical

B. Section 26 0502 Electrical Demolition

C. Section 26 0519 Low Voltage Electrical Power Conductors and Cables

D. Section 26 0526 Grounding and Bonding for Electrical Systems

E. Section 26 0529 Hangers and Supports for Electrical Systems

F. Section 26 0533 Raceway and Boxes for Electrical Systems

G. Section 26 0536 Cable Trays for Electrical Systems

H.	Section 26 0543	Underground Ducts and Raceways for Electrical Systems
I.	Section 26 0548	Seismic Controls for Electrical Systems
J.	Section 26 0550	Installation Coordination
K.	Section 26 0553	Identification for Electrical Systems
L.	Section 26 0573	Electrical System Studies
M.	Section 26 0880	Electrical Acceptance Testing
N.	Section 26 0923	Digital Occupancy and Daylight Management System
O.	Section 26 1213	Liquid Filled, Medium Voltage Transformers
P.	Section 26 2213	Low Voltage Distribution Transformers
Q.	Section 26 2413	Switchboards
R.	Section 26 2416	Panelboards
S.	Section 26 2726	Wiring Devices
T.	Section 26 2813	Fuses
U.	Section 26 2816	Enclosed Switches and Circuit Breakers
V.	Section 26 4313	Transient Voltage Suppression for Low Voltage Electrical Power Circuits
W.	Section 26 5119	LED Interior Lighting
X.	Section 26 5219	Emergency and Exit Lighting
Y.	Section 25 5568	Athletic Field lighting
Z.	Section 26 5612	LED Exterior Lighting

1.4 CODES AND PERMITS

A. Perform electrical work in strict accordance with the applicable provisions of the National Electrical Code, Latest Edition; National Electric Safety Code, Latest Edition; [the International Building Code, Latest Edition as adopted and interpreted by the State of New Mexico, Pueblo of Zuni, and the National Fire Protection Association (NFPA Regulations), current adopted edition. Provide all materials and labor necessary to comply with rules, regulations and ordinances. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. The Contractor shall hold and save the Engineer free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

B. Secure and pay for all permits necessary for performance of the work. Pay for all utility connections unless otherwise specified herein.

C. The following lists applicable codes and standards that, as a minimum, shall be followed.

1. Applicable county and state electrical codes, laws and ordinances.

2. National Electrical Manufacturer's Association Standards

3. National Electrical Code

4. National Electrical Safety Code

5. Underwriters Laboratories, Inc. Standards

6. American National Standards Institute

7. American Society for Testing Materials Standards

8. Standards and requirements of local utility companies

9. National Fire Protection Association Standards

10. Institute of Electrical and Electronics Engineers Standards

11. Insulated Cable Engineers Association

12. Occupational Safety and Health Act

13. Uniform Fire Code

14. Americans with Disabilities Act

15. Commercial and Industrial Insulation Standards (MICA)

1.5 RECORD DRAWINGS

A. Maintain a complete and accurate set of marked up blue-line prints showing information on the installed location and arrangement of all electrical work, and in particular, where changes were made during construction. Use red color to indicate additions or corrections to prints, green color to indicate deletions, and yellow color to indicate items were installed as shown. Keep record drawings accurate and up-to-date throughout the construction period. Record drawings may be reviewed and checked by the Architect, Engineer, Owner's Representative, during the construction and in conjunction with review and approval of monthly pay requests. Include copies of all addenda, RFI's, bulletins, and change orders neatly taped or attached to record drawing set. Transmit drawings to the Architect, Engineer, Owner's Representative, at the conclusion of the project for delivery to the Owner's Representative.

B. PROJECT CLOSEOUT. In addition to the requirements specified in Division 1, indicate installed conditions for:

1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.

2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.

3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.6 QUALIFICATIONS

A. All electricians shall be skilled in their respective trade.

1.7 SUBSTITUTIONS

A. Substitutions:

1. Substitutions after bid, will only be allowed, for equipment, luminaires, devices, and materials listed within these Specifications and in the Equipment Schedules on the drawings, which will be discontinued with-in six months of construction start.

2. Substitutions shall be approved in writing by the Owner or the Owners representatives. The determination of the Owner shall be final. All substation requests shall be submitted for approval two weeks prior to final addendum to actual bid date.

B. Identification of Division 26 equipment, luminaires, devices, and materials listed within this Specification and in the Equipment Schedules on the drawings, which are identified by manufacturer's name, trade name, and/or model numbers are generally not meant to give preference to any manufacturer, but are provided to establish the design requirements and standards.

C. Equipment submitted for substitution must fit the space conditions leaving adequate room for maintenance around all equipment. A minimum of 36 inches, or more if required by Code, must be maintained clear in front of all electrical panels, starters, gutters, or other electrical apparatus. Submit drawings showing the layout, size and exact method of interconnection of conduit, wiring and controls specific to each sequence of operation, which shall conform to the manufacturer's recommendations to meet the specifications specific requirements. The scale of these drawings shall be scale of Contract Drawings. The Contractor shall bear the excess costs, by any and all crafts, of fitting the equipment into the space and the system designated. Where additional labor or material is required to permit equipment submitted for substitution to function in an approved manner, this shall be furnished and installed by the Contractor without additional cost to the Owner.

D. Equipment submitted for substitution shall be approved in writing by the Owner or his representative and shall be accompanied by the following:

1. A sample of each item submitted for substitution shall accompany the submittal.

2. Provide a unit price quotation with each item intended for substitution. Include a unit price for the specified item and a unit price for the intended substitute item. Provide a total (per item) of the differential payback to the Owner should the intended substitute item be approved as equivalent to that which is specified.

3. Reimburse the Owner for the Architect/Engineer's additional services required to review and process substitutions.

1.8 PRIOR APPROVAL

A. The Engineer will not review submittals for electrical equipment prior to bid ("Prior Approvals"). Refer to specification sections and drawings for requirements and approved vendors.

1.9 HAZARDOUS CONDITIONS

A. Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operation personnel, shall be cut back and/or protected to reduce the risk of injury.

1.10 DEFINITIONS

A. Definitions of terms will be found in the National Electrical Code.

B. Whenever a term is used in this Specification which is defined in the Code, the definition given will govern its meaning in this Specification.

C. Whenever a technical term is used which does not appear in the Code, the definition to govern its meaning in these Specifications will be found in the Standard Dictionary of Electrical and Electronic Terms, published by the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, New Jersey 08855-1331.

D. "Provide" means furnish, install, connect and test unless otherwise noted.

1.11 SUBMITTALS

A. The Contractor shall submit submittal brochures of equipment, fixtures and materials to be furnished under Division 26.

B. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior review and approval or are installed in a manner which is not in conformance with the requirement of this Specification and for which the Contractor has not received a written review, removal of the unauthorized materials and installation of those indicated or specified shall be provided at no change in contract amount.

C. Install equipment in accordance with the manufacturer's recommendations. Provide accessories and components for optimum operation as recommended by the manufacturer.

D. Costs for the preparation, correction, delivery, and return of the submittals shall be borne by the Contractor.

E. Complete data must be furnished showing performance, quality and dimensions. No equipment or materials shall be purchased prior to receiving written notification from the Architect/Engineer that submittals have been reviewed and marked either "NO EXCEPTIONS TAKEN" or "EXCEPTIONS AS NOTED." Submittals returned marked "EXCEPTIONS AS NOTED" do not require resubmittal provided that the Contractor agrees to comply with all exceptions noted in the submittal, and so states in a letter to the Architect/Engineer.

F. Review of Submittals: Submittals will be reviewed with reasonable promptness, but only for conformance with the design concept of the Project and for conformance with the information indicated on the Drawings and stated in the Specifications. Review of a separate item as such will not indicate review of the assembly in which the item functions. Review of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents, nor for errors or omissions in the submittals; or for the accuracy of dimensions and quantities, the adequacy of connections, and the proper and acceptable fitting, execution, functioning and completion of the work. Review shall not relieve the Contractor of responsibility for the equipment fitting within the allotted space shown on the drawings with all clearances required for equipment operation, service and maintenance including a minimum of 3 feet clear in front of all electrical equipment and panels as defined by the National Electrical Code. Any relocation of mechanical and/or electrical equipment, materials and systems required to comply with minimum clearances shall be provided by the Contractor without additional cost under the Contract.

G. Shop Drawings: Unless the following information is included, shop drawings will be returned unchecked:

1. Cover sheet for each submittal, listing equipment, products, and materials, and referencing data and sections in Specifications and drawings. Clearly reference project name and provide space for a review stamp.

2. Cover sheet shall clearly identify deviations from specifications, and justification.

3. Include all related equipment in a single submittal to allow complete review. Similar equipment may be submitted under a common cover sheet.

4. Size, dimensions, and weight of equipment.

5. Equipment performance under specified conditions, not a copy of scheduled data on drawings.

6. Indicate actual equipment proposed, where data sheets indicate more than one (1) device or equipment.

H. Use of substitutions reviewed and checked by the Engineer does not relieve the Contractor from compliance with the Contract Documents. Contractor shall bear all extra expense resulting

from the use of any substitutions where substitutions affect adjoining or related work required in this Division or other Divisions of this Specification.

I. If Contractor substitutes equipment for that drawn to scale on the drawings, he shall prepare a 1/4" = 1'-0" installation drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, and including piping, and electrical equipment requirements, to verify that equipment will fit space with adequate clearances for maintenance. This 1/4" = 1'-0" fabrication drawing shall be submitted, for review by the Architect, Engineer, Owner's Representative, with the shop drawing submittals of the substituted. Failure to comply with this requirement will result in the shop drawings being returned unchecked.

J. Submittals and one (1) resubmittal will be reviewed by the Architect/Engineer. If the Contractor fails to provide the required data with his second submittal, he will be charged for the third and subsequent reviews at $200 dollar per hour.

K. The Contractor shall submit a maximum amount of one PDF copy of submittal brochures for review. Brochures shall be submitted within thirty (30) days after contract award. A copy of all submittals will be retained by the Engineer, and PDF response sets returned to the Architect.

1.12 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1 - PROJECT CLOSEOUT. In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

2. Manufacturer’s printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.

3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

4. Servicing instructions and lubrication charts and schedules.

1.13 COORDINATION DRAWINGS

A. Prepare coordination drawings in accordance with Division 1, Section "PROJECT COORDINATION", to a scale of 1/8" = 1'-0" or larger; detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of major raceway systems, equipment, and materials. Include the following:

a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.

b. Exterior wall and foundation penetrations.

c. Fire-rated wall and floor penetrations.

d. Equipment connections and support details.

e. Sizes and location of required concrete pads and bases.

2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

4. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communications systems components, sprinklers, and other ceiling-mounted devices.

1.14 USE OF CADD FILES

A. Under certain conditions, the Contractor will be permitted the use of the Engineer's CADD files for documentation of as-builts, submittals, or coordination drawings.

B. The Engineer shall be compensated for the time required to format the CADD files for delivery to the Contractor. Such work may include removal of title blocks, professional seals, calculations, proprietary information, etc.

C. The Contractor shall complete the enclosed License, Indemnity and Warranty Agreement, complete with contractor's name, address, and Contractor's Representative signature prior to request for CADD file usage.

1.15 DRAWINGS AND SPECIFICATIONS

A. Electrical drawings are diagrammatic, but shall be followed as closely as actual construction and work of the other sections shall permit. Size and location of equipment is drawn to scale wherever possible. Do not scale from electrical drawings.

B. Drawings and specifications are for the assistance and guidance of the Contractor. Exact locations, distances, and levels will be governed by the building. The Contractor shall make use of data in all the Contract Documents to verify information at the building site.

C. In any case where there appears to be a conflict between that which is shown on the electrical drawings, and that shown in any other part of the Contract Documents, the Contractor shall notify and secure directions from the Architect.

D. Drawings and specifications are intended to complement each other. Where a conflict exists between the requirements of the drawings and/or the specifications, request clarification. Do not proceed with work without direction.

E. The Architect shall interpret the drawings and the specifications. The Architect's interpretation as to the true intent and meaning thereof and the quality, quantity, and sufficiency of the materials and workmanship furnished there under shall be accepted as final and conclusive.

F. In the case of conflicts not clarified prior to the bidding deadline, use the most costly alternative (better quality, greater quantity, and larger size) in preparing the bid. A clarification will be issued to the successful bidder as soon as feasible after the award and, if appropriate, a deductive change order will be issued.

G. Where items are specified in the singular, this division shall provide the quantity as shown on drawings plus any spares or extras indicated on the drawings or in the specifications.

H. Investigate structural and finish conditions and arrange work accordingly. Provide all fittings, equipment, and accessories required for actual conditions.

1.16 SIMILAR MATERIALS

A. All items of a similar type shall be products of the same manufacturer.

B. Contractor shall coordinate among suppliers of various equipment to assure that similar equipment type is product of the same manufacturer.

C. Examples of similar equipment types include but are not limited to:

1. Power Circuit Breakers
2. Enclosed Case Circuit Breakers
3. TVSS
4. Motor Starters
5. Transformers
6. Panelboards
7. Disconnects
8. Fuses

1.17 DELIVERY, STORAGE AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.18 GUARANTEE-WARRANTY

A. The following guarantee is a part of the specifications and shall be binding on the Contractor:

"The Contractor guarantees that this installation is free from ALL defects. He agrees to replace or repair any part of the installation which may fail within a period of one (1) year after date established below, provided that such failure is due to defects in the materials or workmanship or to failure to follow the specifications and drawings. Warranty of the Contractor-furnished equipment or systems shall begin on the date the system or equipment is placed in operation for beneficial use of the Owner or occupancy by the Owner, whichever occurs first; such date to be determined in writing by means of issuing a 'Certificate of Substantial Completion', AIA Form G704."

B. The extent of guarantees or warranties by Equipment and/or Materials Manufacturers shall not diminish the requirements of the Contractor's guarantee-warranty to the Owner.

C. All items of electrical equipment furnished and installed under Division 26 shall be provided with a full two (2) year parts and labor warranty.

PART 2 - PRODUCTS

2.1 QUALITY OF MATERIALS

A. All equipment and materials shall be new, and shall be the standard product of manufacturers regularly engaged in the production of electrical equipment, and shall be the manufacturer's latest design. Specific equipment, shown in schedules on drawings and specified herein, is to set forth a standard of quality and operation.

B. Hazardous or Environmentally Damaging Materials: Products shall not contain asbestos, mercury, PCBs, or other materials harmful to people or the environment.

2.2 ALTITUDE RATINGS

A. Unless otherwise noted, all specified equipment capacities are for an altitude of 6,293 feet above sea level and adjustments to manufacturer's ratings must be made accordingly.

2.3 EQUIPMENT REQUIREMENTS

A. The electrical requirements for equipment specified or indicated on the drawings are based on information available at the time of design. If equipment furnished for installation has electrical requirements other than those indicated on the electrical drawings, make all adjustments to wire and conduit size, controls, over current protection and installation as required to accommodate the equipment supplied. Delineate all adjustments to the drawings reflecting the electrical system in a submittal to the Contract Administrator immediately upon knowledge of the required adjustment.

B. Approved Equipment and Conductors: ALL equipment and conductors shall be listed and labeled by a nationally recognized testing laboratory (NRTL). The NRTL shall be listed by the federal occupational safety and health administration. Conformance with the State of New Mexico Electrical Code article 110.2 is required for ALL equipment and conductors.

PART 3 - EXECUTION

3.1 COOPERATION WITH OTHER TRADES

A. Coordinate all work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. The Contractor shall be responsible for the size and accuracy of all openings.

3.2 DRAWINGS

A. The electrical drawings show the general arrangement of all lighting, power, special systems, equipment, etc., and shall be followed as closely as actual building construction and work of other trades will permit. Whenever discrepancies occur between plans and specifications, the most stringent shall govern. All Contract Documents shall be considered as part of the work. Coordinate with architectural, mechanical, and structural drawings. Because of the small scale of the electrical drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. Provide all fittings, boxes, and accessories as may be required to meet actual conditions. Should conditions necessitate a rearrangement of equipment, such departures and the reasons therefore, shall be submitted by the Contractor for review in the form of detailed drawings showing the proposed changes. No changes shall be made without the prior written approval. All changes shall be marked on record drawings.

B. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, the question shall be submitted in writing.

C. Installation of all equipment shall be arranged to provide all clearances required for equipment operation, service, and maintenance, including minimum clearance, as defined by the National Electrical Code (NEC).

D. The Contractor's attention is directed to the unique architectural design features and consideration associated with this facility which will require significantly greater levels of coordination and cooperation for the work furnished and installed under Division 26 with the associated architectural, structural, and mechanical work than is normally necessary for a more typical facility.

E. The installation of all concealed electrical systems shall be carefully arranged to fit within the available space without interference with adjacent structural and mechanical systems.

3.3 ELECTRICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of electrical system, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with all other building components.

2. Verify all dimensions by field measurements.

3. Arrange for chases, slots, and openings in all other building components during progress of construction, to allow for electrical installations.

4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.

5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum clearance possible.

7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

8. Branch circuits in all areas to have an individual neutral for each phase.

9. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.

10. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.

11. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

12. Install access panel or doors where units are concealed behind finished surfaces.

13. Install systems, materials, and equipment giving right-of-way priority to systems requiring installation at a specified slope.

3.4 FIELD MEASUREMENTS

A. No extra compensation shall be claimed or allowed due to differences between actual dimensions, including dimensions of equipment, fixtures and materials furnished, and those indicated on the drawings. Contractor shall examine adjoining work, and shall report any work which must be corrected. Review of submittal data in accordance with paragraph "Submittals" shall in no manner relieve the Contractor of responsibility for the proper installation of the

electrical work within the available space. Installation of equipment and systems within the building space shall be carefully coordinated by the Contractor.

3.5 EQUIPMENT SUPPORT

A. Provide support for equipment to the building structure. Provide all necessary structures, inserts, sleeves, firestops and hanging devices for installation of equipment. Coordinate installation of devices. Verify with the Architect that the devices and supports are adequate as intended and do not overload the building's structural components in any way.

3.6 PAINTING

A. All finish painting of electrical systems and equipment will be under "Painting," unless equipment is hereinafter specified to be painted.

B. All equipment shall be provided with factory applied standard finish, unless otherwise specified.

C. Touch-Up: If the factory finish on any equipment is damaged in shipment or during construction of the building, the equipment shall be refinished to the satisfaction of the Architect, Engineer, and Owner’s Representative.

3.7 SEISMIC SUPPORTS

A. The Contractor shall be responsible for all anchors and connections for the electrical work to the building structure to prevent damage of equipment and systems due to seismic activity.

B. See Section 26 0548 Seismic Controls for Electrical Systems for requirements for seismic supporting of electrical equipment and systems.

3.8 PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be responsible for the protection of all work, materials and equipment furnished and installed under this section of the specifications, whether incorporated in the building or not.

B. All items of electrical equipment shall be stored in a protected weatherproof enclosure prior to installation within the building, or shall be otherwise protected from the weather in a suitable manner approved by the Architect, Engineer, and Owner’s Representative.

C. The Contractor shall provide protection for all work and shall be responsible for all damage done to property, equipment and materials. Storage of materials within the building shall be approved by the Architect, Engineer, and Owner’s Representative prior to such storage.

D. Conduit openings shall be closed with caps or plugs, or covered to prevent lodgment of dirt or trash during the course of installation. At the completion of the work, fixtures, equipment and materials shall be cleaned and polished thoroughly and delivered in a condition satisfactory to the Architect, Engineer, and Owner’s Representative.

3.9 EXCAVATION

A. Provide all excavation, trenching and backfilling required.

B. Slope sides of excavations to comply with codes and ordinances. Shore and brace as required for stability of excavation.

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.11 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.12 APPLICATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturer’s printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.

2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

B. Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

C. Firestopping Sealant: Provide sealant, including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.13 INSTALLATION OF ACCESS DOORS

A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

B. Adjust hardware and panels after installation for proper operation.

3.14 CUTTING AND PATCHING

A. Perform cutting and patching in accordance with Division 1, Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:

1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
    a. Remove and replace defective Work.
    b. Remove and replace Work not conforming to requirements of the Contract Documents.
    c. Remove samples of installed Work as specified for testing.
    d. Install equipment and materials in existing structures.
    e. Upon written instructions from the Contracting Officer, uncover and restore Work to provide for Contracting Officer observation of concealed Work.

2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.

3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

5. During cutting and patching operations, protect adjacent installations.

6. Patch existing finished surfaces and building components using new materials matching existing materials and experienced installers.

3.15 ANUFACTURER'S INSTRUCTIONS

A. All equipment shall be installed in strict accordance with recommendations of the manufacturer. If such recommendations conflict with plans and specifications, the Contractor shall submit such conflicts to the Architect, Engineer, and Owner’s Representative who shall make such compromises as he deems necessary and desirable.

3.16 OWNER FURNISHED EQUIPMENT

A. Included in Work Scope:

1. Follow and expedite the delivery of each piece of equipment to assure the equipment delivery stays on schedule. Notify the Owner of any problems or delays.

2. Receive, unload, uncrate, and install each item of pre-purchased and Owner furnished equipment.

3. Confirm that each item has been received complete and as specified. Notify the Owner and the manufacturer's representative in writing of any deficiencies or damage.

4. Coordinate with the manufacturer's representative on start-up and provide factory personnel, and provide all necessary personnel to assist Owner's operating personnel and/or manufacturer's service personnel in start-up and commissioning.

5. Provide all items not listed as pre-purchased.

B. The Contractor shall not be responsible for the following in regards to pre-purchased and Owner furnished equipment:

1. Payment

2. Equipment Warranty

3. Submittals

4. Operating and Maintenance Manuals

5. Equipment Performance

C. Submittals, installation instructions, and warranty provisions for pre-purchased equipment will be furnished to the Contractor by the Owner.

3.17 CONCRETE BASES AND HOUSEKEEPING PADS

A. Install concrete bases and housekeeping pads under all freestanding electrical equipment unless otherwise noted.

B. Contractor shall be responsible for the accurate dimensions of all pads and bases and shall furnish and install all anchor bolts, etc. Coordinate weight of concrete bases and housekeeping pads with the structural engineer.

C. All concrete bases and housekeeping pads shall conform to the requirements specified under Division 3, Concrete, portions of these specifications. Pad foundations shall be 4" high minimum, unless otherwise indicated on the drawings. Chamfer edges shall be 1". Faces shall be free of voids and rubbed smooth with Carborundum block after stripping forms. Tops shall be level. Provide dowel rods or other required material in floor for lateral stability and anchorage.

D. Equipment anchor bolts shall be set in a galvanized pipe or sheet metal sleeves 1" larger than bolt diameter. Anchor bolts shall be high strength steel J shape. Anchor bolt design shall be arranged and paid for by the Contractor.

3.18 TESTS

A. All tests shall be conducted in the presence of the designated and authorized Owner's Representative. The Contractor shall notify the Architect, Engineer, and Owner's Representative one week in advance of all tests. The Contractor shall furnish all necessary equipment, materials, and labor to perform the required tests.

3.19 OPERATION AND MAINTENANCE INSTRUCTIONS

A. The Contractor shall furnish the complete operating and maintenance instructions covering all units of electrical equipment herein specified together with parts lists. Furnish two (2) copies of all the literature; each shall be suitably bound in loose leaf book form.

B. Operating and maintenance manuals as required herein shall be submitted for review not less than two (2) weeks prior to the date scheduled for the Contractor to provide Operating and Maintenance Instructions to the Owner as specified herein.

C. Upon completion of all work and all tests, Contractor shall furnish the necessary skilled labor and helpers for operating the electrical systems and equipment for a period of five (5) days of eight (8) hours each. During this period, the Contractor shall instruct the Owner or his representative in the operations, adjustment and maintenance of all equipment furnished. Contractor shall provide at least two weeks' notice in advance of this period, with a written schedule of each training session, the subject of the session, the Contractors' representatives who plan to attend the session, and the time for each session.

D. The Contractor shall video tape the instruction and training sessions using a VHS or DVD camcorder, and at the completion and acceptance (by Owner and Architect) of the training sessions, the Contractor shall submit (2) copies of the video tape.

3.20 CERTIFICATIONS

A. Before receiving final payment, certify in writing that all equipment furnished and all work done is in compliance with all applicable codes mentioned in these specifications. Submit certifications and acceptance certificates to the Architect, Engineer, and Owner's Representative including proof of delivery of O&M manuals, spare parts required, and equipment warranties which shall be bound with O&M manuals.

3.21 INTERRUPTING SERVICES

A. The Contractor shall coordinate the installation of all work within the building in order to minimize interference with the operation of existing building electrical telephone, fire alarm, and utility systems during construction. Connections to existing systems requiring the interruption of service within the building shall be carefully coordinated with the Owner to minimize system downtimes. Requests for the interruption of existing services shall be submitted in writing a minimum of two (2) weeks before the scheduled date. Absolutely no interruption of the existing services will be permitted without the written review.

3.22 OPERATION PRIOR TO ACCEPTANCE

A. Operation of equipment and systems installed by the Contractor for the benefit of the Owner prior to substantial completion will be allowed providing a written agreement between the Owner and the Contractor has established warranty and other responsibilities to the satisfaction of both parties.

3.23 SITE VISITS AND OBSERVATION OF CONSTRUCTION

A. The Architect/Engineer will make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the Contractor's work, in order to determine in general if such work is proceeding in accordance with the Contract Documents. This observation by the Architect/Engineer however, shall in no way release the Contractor from his complete responsibility to supervise, direct, and control all construction work and activities, nor shall the Architect/Engineer have authority over, or a responsibility to means, methods, techniques, sequences, or procedures of construction provided by the Contractor or for safety precautions and programs, or for failure by the Contractor to comply with all law, regulations, and codes.

END OF SECTION 26 0500

DIVISION 26 SUBSTITUTION REQUEST FORM (SRF)

TO: BRIDGERS & PAXTON CONSULTING ENGINEERS, INC.

PROJECT:_____

We hereby submit for your consideration the following product instead of the specified item for the above project:

Section: _____ Page:_____ Paragraph/Line:_____ Specified Item:_____
Proposed Substitution: _____

Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitutions? YES ☐ NO ☐
   If YES, explain:_____
2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions? YES ☐ NO ☐
3. List differences between proposed substitutions and specified item.

Specified Item	Proposed Substitution
_____	_____
_____	_____
_____	_____

4. Does substitution affect Drawing dimensions? YES ☐ NO ☐
5. What affect does substitution have on other trades? _____
   _____
6. Does the manufacturer's warranty for proposed substitution differ from that specified? YES ☐ NO ☐
   If YES, explain: _____
   _____
7. Will substitution affect progress schedule? YES ☐ NO ☐
   If YES, explain: _____
   _____
8. Will maintenance and service parts be locally available for substitution? YES ☐ NO ☐
   If YES, explain: _____
   _____
9. Is substitution identical in appearance and function to specialized product? YES ☐ NO ☐

Submitting Firm: _____ Date: __
Address: _____
Signature: _____ Telephone: _____

For Engineer's Use Only
Accepted:_____ Not Accepted:_____ Received Too Late:_____
By:_____ Date:_____
Remarks:_____
_____

LICENSE AGREEMENT FOR CADD DATABASE OR BIM MODEL

PROJECT: _____

LICENSE GRANT: Contractor is granted use of the CADD Database or BIM Model (Database/Model) for the indicated project for the specific purpose of preparing submittal documents for this Project. No other use of the Database/Model is granted. Title to the Database/Model is not transferred to the Contractor. The Database/Model may be of value to the Contractor in preparing submittals, but use of the model does not relieve the contractor of the requirement to verify measurements in the field.

COPYING RESTRICTIONS: Contractor may copy the Database/Model in whole or in part, but only for backup and archival purposes or for use by the Contractor's Subcontractors. Contractor agrees to ensure that any entities that receive the Database/Model from Contractor, either in whole or in part, comply with the terms and conditions of this agreement. Contractor shall safeguard the Database/Model from falling into the hands of parties other than Subcontractors with a legitimate need for it.

WARRANTY: Bridgers & Paxton (B&P) offers this Database/Model without warranty and specifically without express or implied warranty of fitness. If Contractor chooses to use the Database/Model, then he does so at his own risk and without any liability or risk to B&P.

INDEMNITY: Contractor shall to the fullest extent permitted by law, defend, indemnify and hold harmless the Owner, Architect, B&P, their employees and agents from all claims, damages, losses, and attorney fees arising out of or resulting from the use of the Database/Model.

ACKNOWLEDGMENT: Contractor acknowledges that (s)he has read this Agreement, understands it, and agrees to be bound by its terms and conditions.

CONTRACTOR'S REPRESENTATIVE

Signature: _____ Company Name: _____

Name: _____ Address 1: _____

Title: _____ Address 2:_____

Date: _____

SECTION 26 0502 – DEMOLITION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. See Section 260500 for Common Work Results for Electrical.

1.2 SCOPE OF WORK

A. Provide all material, equipment and labor as required to remove, relocate and/or reconnect all electrical work identified in these specifications and indicated on the drawings.

1.3 SUMMARY

A. This Section includes limited scope, general construction materials and methods for application with electrical installations as follows:

1. Selective demolition including:

a. Nondestructive removal of materials and equipment for reuse or salvage as indicated.

b. Dismantling electrical materials and equipment made obsolete by these installations.

2. Excavation for underground utilities and services, including underground raceways.

3. Miscellaneous metals for support of electrical materials and equipment.

4. Nailers, blocking, fasteners, and anchorage for support of electrical materials and equipment.

5. Joint sealers for sealing around electrical materials and equipment; and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.

6. Access panels and doors in walls, ceilings, and floors for access to electrical materials and equipment.

1.4 PROJECT CONDITIONS

A. Conditions affecting selective demolition: The following project conditions apply:

1. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

2. Locate, identify, and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

B. Conditions affecting excavations: The following project conditions apply:

1. Maintain and protect existing building services which transit the area affected by selective demolition.

2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.

3. Existing utilities: Locate existing underground utilities in excavation areas. If utilities are indicated to remain, support and protect services during excavation operations.

4. Remove existing underground utilities indicated to be removed.

a. Uncharted or incorrectly charted utilities: Contact utility owner immediately for instructions.

b. Provide temporary utility services to affected areas. Provide minimum of 48-hour notice to Owner's Representative prior to utility interruption.

5. Use of explosives is not permitted.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Verify field measurements and circuiting arrangements as shown on drawings.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition drawings are based on casual field observation and existing record documents. Report discrepancies to Architect/Engineer before disturbing existing installation.

D. Beginning of demolition means Contractor accepts existing conditions.

PART 3 - EXECUTION

3.1 PREPARATION

A. Disconnect and remove electrical systems in walls, floors, and ceilings scheduled for removal.

B. Coordinate utility service outages with Owner a minimum of 72 hours prior to outage.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

D. Existing Electrical and Fire Alarm system: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switch overs and connections. Obtain permission from the Owner's Representative at least 72 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

3.2 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Demolish and extend existing electrical work under provisions of this section.

B. Remove, relocate and extend existing installations to accommodate new construction. Re-circuit and reconnect all electrical lighting, outlets, and equipment not scheduled for removal that have become disconnected due to demolition work.

C. Remove abandoned wiring to source of supply.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit serving them is removed. Provide blank cover for abandoned outlets which are not removed. Provide blank cover for abandoned outlets which are not removed.

F. Disconnect and remove abandoned panelboards and distribution equipment.

G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

H. Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers, and other accessories.

I. Repair adjacent construction and finishes damaged during demolition and extension work. Any damage to building, piping or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner.

J. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

L. Removal and replacement of ceiling tile(s) to perform work operations shall be the responsibility of the Contractor. The Contractor shall be responsible for replacement of any ceiling tiles or framework that may become damaged at no cost to the Owner

M. Disconnect and remove [ ].

N. Housekeeping Pads and Equipment Foundations: Remove for all equipment removal. Backfill as required, compact to 95 percent modified Proctor density, and pour floor slab or resurface floor to match existing.

O. Conduit in Concealed Locations: Remove conductors, cap both ends of conduit, and label conduit as "Abandoned" at both ends. Where conduit runs below grade, cap both ends of conduit and abandon in place. Where conduit runs below floor slab, additionally, chip out concrete around conduit, remove conduit to bottom of slab level, and patch floor to match existing.

P. Motor Control Centers: Where MCCs serve equipment to be removed and no new equipment is to be served, leave starter in place, remove existing labels, and install new label "Spare Size x Starter."

3.3 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

C. Luminaries: Remove existing luminaries for cleaning, as indicated on drawings. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

D. Materials and equipment to be salvaged: Remove, demount, and disconnect existing electrical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

E. Disposal and cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

3.4 INSTALLATION

A. Install relocated materials and equipment under the provisions of this section.

3.5 ITEMS SALVAGED TO OWNER

A. All items removed and or salvaged will have Owner first right of refusal and approval for removal from site. Move and store in dry location as directed. Refuse materials and items not salvaged shall be removed from the site and legally disposed of.

END OF SECTION 26 0502

SECTION 26 0519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Copper building wire.
2. Aluminum building wire.
3. Nonmetallic underground conduit with conductors, Type NUCC.
4. Metal-clad cable, Type MC.
5. Armored cable, Type AC.
6. Photovoltaic cable, Type PV.
7. Mineral-insulated cable, Type MI.
8. Tray cable, Type TC.
9. Fire-alarm wire and cable.
10. Connectors and splices.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 260513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35 000 V.

4. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.

5. Section 271313 "Communications Copper Backbone Cabling" for twisted pair cabling used for data circuits.

6. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair cabling used for data circuits.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: Indicate type, use, location, and termination locations.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alpha Wire Company.

2. American Bare Conductor.

3. Belden Inc.

4. Cerro Wire LLC.

5. Encore Wire Corporation.

6. General Cable Technologies Corporation.

7. Okonite Company (The).

8. Service Wire Co.

9. Southwire Company.

10. WESCO.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B496 for stranded conductors.

E. Conductor Insulation:

1. Type NM: Comply with UL 83 and UL 719.

2. Type RHH and Type RHW-2: Comply with UL 44.

3. Type USE-2 and Type SE: Comply with UL 854.

4. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.

5. Type THHN and Type THWN-2: Comply with UL 83.

6. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.

7. Type UF: Comply with UL 83 and UL 493.

8. Type XHHW-2: Comply with UL 44.

9. <Insert Type and standard>.

F. Shield:

1. Type TC-ER: Cable designed for use with ASDs, with oversized crosslinked polyethylene insulation, [spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire] [dual spirally wrapped copper tape shields and three bare symmetrically applied ground wires], and sunlight- and oil-resistant outer PVC jacket.

2.2 FIRE-ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allied Wire & Cable Inc.

2. CommScope, Inc.

3. Comtran Corporation.

4. Genesis Cable Products; Honeywell International, Inc.

5. Radix Wire.

6. Rockbestos-Suprenant Cable Corp.

7. Superior Essex Inc.

8. West Penn Wire.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG size as recommended by system manufacturer.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.

2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.

3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

2.3 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. 3M Electrical Products.

2. ABB (Electrification Products Division).

3. Appleton - O-Z/Gedney; Emerson Electric Co., Automation Solutions.

4. Atkore International (AFC Cable Systems).

5. Gardner Bender.

6. Hubbell Incorporated, Power Systems.

7. Ideal Industries, Inc.

8. ILSCO.

9. NSi Industries LLC.

10. Service Wire Co.

11. TE Connectivity Ltd.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

1. Material: Copper.

2. Type: Two hole with standard long barrels.

3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders:

1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

2. Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors must be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits:

1. Minimum #12 conductors to be used throughout building unless noted in the specifications or in the plans.

2. Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3. Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

C. ASD Output Circuits Cable: Extra-flexible stranded for all sizes.

D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 INSTALLATION, GENERAL

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

3.3 INSTALLATION OF FIRE-ALARM WIRE AND CABLE

A. Comply with NFPA 72.

B. Wiring Method: Install wiring in metal pathway according to Section 270528.29 "Hangers and Supports for Communications Systems."

1. Install plenum cable in environmental airspaces, including plenum ceilings.

2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system must be installed in a dedicated pathway system.

    a. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.

3. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is not permitted.

4. Signaling Line Circuits: Power-limited fire-alarm cables must not be installed in the same cable or pathway as signaling line circuits.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.

F. Risers: Install at least two vertical cable risers to serve the fire-alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent receipt or transmission of signals from other floors or zones.

G. Wiring to Remote Alarm Transmitting Device: 1 inch conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material[and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors].

1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inch of slack.

D. Comply with requirements in Section 283100 "Addressable Fire-Alarm Systems" for connecting, terminating, and identifying wires and cables.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.

2. After installing conductors and cables and before electrical circuitry has been energized, test **service entrance and feeder conductors, and conductors** feeding the following critical equipment and services for compliance with requirements:

    a. Switchboard,

    b. Panelboards.

    c. Transformers,

    d. Mechanical system Equipment

    e. Plumbing system Equipment.

    f. Appliances and vending machines

    g. Special equipment such as copiers and the like.

3. Perform each of the following visual and electrical tests:

    a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.

    b. Test bolted connections for high resistance using one of the following:

        1) A low-resistance ohmmeter.

        2) Calibrated torque wrench.

        3) Thermographic survey.

    c. Inspect compression-applied connectors for correct cable match and indentation.

    d. Inspect for correct identification.

    e. Inspect cable jacket and condition.

f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.

g. Continuity test on each conductor and cable.

h. Uniform resistance of parallel conductors.

4. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

b. 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.

5. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

B. Cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports to record the following:

1. Procedures used.

2. Results that comply with requirements.

3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 02 0519

SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes grounding and bonding systems and equipment.

B. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Underground distribution grounding.

2. Ground bonding common with lightning protection system.

3. Foundation steel electrodes.

C. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test wells.

2. Ground rods.

3. Ground rings.

4. Grounding arrangements and connections for separately derived systems.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 260500 "Common Work Results for Electrical systems" include the following:

a. Plans showing as-built, dimensioned locations of system described in "Field Quality Control" Article, including the following:

1) Test wells.

2) Ground rods.

3) Ground rings.

4) Grounding arrangements and connections for separately derived systems.

b. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, grounding connections for separately derived systems, based on NETA MTS and NFPA 70B.

1) Tests must determine if ground-resistance or impedance values remain within specified maximums, and instructions must recommend corrective action if values do not.

2) Include recommended testing intervals.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following

1. ABB, Electrification Products Division.

2. Advanced Lightning Technology, Ltd.

3. Burndy; Hubbell Incorporated, Construction and Energy.

4. Dossert; AFL Telecommunications LLC.

5. ERICO; nVent.

6. Fushi Copperweld Inc.

7. Galvan Industries, Inc.; Electrical Products Division, LLC.

8. Harger Lightning & Grounding.

9. ILSCO.

10. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.

11. Robbins Lightning, Inc.

12. Siemens Industry, Inc., Energy Management Division.

2.3 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.

2. Stranded Conductors: ASTM B8.

3. Tinned Conductors: ASTM B33.

4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.

5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.

7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, ¼" by 4 inch by 12" in cross section, with 9/32 inch holes spaced 1-1/8 inch apart. Stand-off insulators for mounting must comply with UL 891 for use in switchboards, 600 V and must be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Mechanical-Type Bus-Bar Connectors: Cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Compression-Type Bus-Bar Connectors: Copper or copper alloy, with two wire terminals.

E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

F. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

G. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

H. Conduit Hubs: Mechanical type, terminal with threaded hub.

I. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

J. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

K. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.

L. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.

M. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.

N. Straps: Solid copper, copper lugs. Rated for 600 A.

O. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal one-piece clamp.

P. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

Q. Water Pipe Clamps:

1. Mechanical type, two pieces with stainless steel bolts.

    a. Material: Die-cast zinc alloy.

    b. Listed for direct burial.

2. U-bolt type with malleable-iron clamp and copper ground connector rated for direct burial.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad; 3/4 inch by 10 ft.

B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.

1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inch long.

2. Backfill Material: Electrode manufacturer's recommended material.

C. Ground Plates: 1/4 inch thick, hot-dip galvanized.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for **No. 8 AWG** and smaller, and stranded conductors for **No. 6 AWG** and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, **No. 4/0 AWG** minimum.

1. Bury at least 30 inch below grade.

2. Duct-Bank Grounding Conductor: Bury 12 inch above duct bank when indicated as part of duct-bank installation.

C. Grounding Conductors: Green-colored insulation with continuous yellow stripe.

D. Isolated Grounding Conductors: Green-colored insulation with more than one continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

E. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inch minimum from wall, 6 inch above finished floor unless otherwise indicated.

2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

F. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.

3. Connections to Ground Rods at Test Wells: Bolted connectors.

4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors must be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode must be connected to the equipment grounding conductor and to the frame of the generator.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inch will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inch above to 6 inch below concrete. Seal floor opening with waterproof, non-shrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inch from the foundation.

3.5 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.

2. Lighting circuits.

3. Receptacle circuits.

4. Single-phase motor and appliance branch circuits.

5. Three-phase motor and appliance branch circuits.

6. Flexible raceway runs.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

F. Metallic Fences: Comply with requirements of IEEE C2.

1. Grounding Conductor: Bare**,** copper, not less than **No. 8 AWG**.

2. Gates: Must be bonded to the grounding conductor with a flexible bonding jumper.

3. Barbed Wire: Strands must be bonded to the grounding conductor.

3.6 FENCE GROUNDING

A. Fence Grounding: Install at maximum intervals of 500 ft. except as follows:

1. Fences within 100 ft. of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of **500 ft.**

a. Gates and Other Fence Openings: Ground fence on each side of opening.

1) Bond metal gates to gate posts.

2) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inch below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 ft. on each side of crossing.

C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.

D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inch below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

F. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.7 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inch below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.

2. Use exothermic welds for all below-grade connections.

3. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and must be at least 12 inch deep, with cover.

1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install copper bonding jumper to bond across flexible duct connections to achieve continuity.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 ft. apart.

I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each indicated item on plans.

1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.

2. Bury ground ring not less than 24 inch from building's foundation.

J. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 ft. of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 ft. long, coil excess conductor within base of foundation.

2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

K. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.

2. Make connections with clean, bare metal at points of contact.

3. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.

4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.

5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.8 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Grounding system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

D. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.

2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: **5** ohms.

3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.

4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).

5. Substations and Pad-Mounted Equipment: 5 ohms.

6. Manhole Grounds: 10 ohms.

E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 0526

SECTION 26 0529 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Support, anchorage, and attachment components.

2. Fabricated metal equipment support assemblies.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Slotted support systems, hardware, and accessories.

b. Clamps.

c. Hangers.

d. Sockets.

e. Eye nuts.

f. Fasteners.

g. Anchors.

h. Saddles.

i. Brackets.

2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: Signed and sealed by a qualified professional engineer**.** For fabrication and installation details for electrical hangers and support systems.

1. Hangers. Include product data for components.

2. Slotted support systems.

3. Equipment supports.

4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittal: For hangers and supports for electrical systems.

1. Include design calculations and details of hangers.

2. Include design calculations for seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M.

2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified structural professional engineer to design hanger and support system.

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame Rating: Class 1.

2. Self-extinguishing according to ASTM D635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center in at least one surface.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following

a. ABB, Electrification Products Division.

b. Allied Tube & Conduit; Atkore International.

c. B-line; Eaton, Electrical Sector.

d. CADDY; nVent.

e. Flex-Strut Inc.

f. Gripple Inc.

g. G-Strut.

h. Haydon Corporation.

i. Metal Ties Innovation.

j. MIRO Industries.

k. Unistrut; Atkore International.

l. Wesanco, Inc.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.

3. Material for Channel, Fittings, and Accessories: [Galvanized steel] [Plain steel] [Stainless steel, Type 304] [Stainless steel, Type 316].

4. Channel Width: Selected for applicable load criteria 1-5/8 inch.

5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) Hilti, Inc.

        2) ITW Ramset/Red Head; Illinois Tool Works, Inc.

        3) MKT Fastening, LLC.

        4) Simpson Strong-Tie Co., Inc.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) B-line; Eaton, Electrical Sector.

        2) Empire Tool and Manufacturing Co., Inc.

        3) Hilti, Inc.

        4) ITW Ramset/Red Head; Illinois Tool Works, Inc.

        5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.

6. Toggle Bolts: All Stainless steel springhead type.

7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 SELECTION

A. Comply with the following standards for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA NEIS 101

2. NECA NEIS 102.

3. NECA NEIS 105.

4. NECA NEIS 111.

B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceway and Boxes for Electrical Systems."

D. Provide vibration and seismic controls with hangers and supports in accordance with requirements specified in "Section 260548 "Seismic Controls for Electrical Systems."

E. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as scheduled in NECA NEIS 1, where its Table 1 lists maximum spacing's that are less than those stated in NFPA 70. Minimum rod size must be 1/4 inch in diameter.

F. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least **25** percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with [two-bolt conduit clamps] [single-bolt conduit clamps] [single-bolt conduit clamps using spring friction action for retention in support channel].

G. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 INSTALLATION

A. MANUFACTURED SUPPORTING DEVICES

1. Conduit Sealing Bushing: Factory-fabricated watertight conduit sealing busing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps and cap screws.

2. U-Channel Systems: 16-gauge steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacturer.

B. FABRICATED SUPPORTING DEVICES

1. Pipe Sleeves: Provide pipe sleeves of one of the following:

2. Sheetmetal: Fabricate from galvanized sheetmetal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gauge metal for sleeve diameter noted:

   a. 3-inch and smaller: 20-gauge.

   b. 4-inch to 6-inch: 16-gauge.

   c. Over 6-inch: 14-gauge.

3. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.

4. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

C. Raceway Supports: Comply with the NEC and the following requirements:

1. Conform to manufacturer's recommendations for selection and installation of supports.

2. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2 inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use ¼-inch-diameter or larger threaded steel. Use spring and steel fasteners that are specifically designed for supporting single conduits or tubing.

3. For cable tray mounting use manufacturers recommended stem rods to carry the cable tray and installed cables at a minimum 200lbs of concentrated load. Comply with requirements in Section 260536 "Cable Tray for Electrical Systems."

4. Space supports for raceways in accordance with Table I of this section. Space supports for raceway types not covered by the above in accordance with NEC.

5. Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.

6. In vertical runs, arrange support so the load produced by the weight of the raceways and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.

D. Vertical Conductor Supports: Install simultaneously with installation of conductors.

E. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks

for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

F. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheetmetal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.

G. Sleeves: Install in concrete slabs and walls and all other fire- rated floors and walls for raceways and cable installations. For sleeves through fire rated-wall or floor construction, apply UL- listed firestopping sealant in gaps between sleeves and enclosed conduits and cables.

H. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.

I. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:

1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheetmetal screws.

2. 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 shall not cut the main reinforcing bars. Fill holes that are not used.

3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock- resistant fasteners for attachments to concrete slabs.

J. Tests: Test pull-out resistance of one of each type, size, and anchorage material for the following fastener types:

1. Expansion anchors.

2. Toggle bolts.

3. Powder-driven threaded studs.

K. Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain the Contracting Officer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.

TABLE I: SPACING FOR RACEWAY SUPPORTS

Raceway Size, In.	Location	RMC & IMC (1)	EMT (1)
1/2-1	Any Location	7	7
1 & Larger	Any Location	10	10

NOTES:

1. Maximum spacing of supports (feet).

2. Maximum spacings for IMC above apply to straight runs only. Otherwise the maximums for EMT apply.

Abbreviations:
EMT Electrical metallic tubing.
IMC Intermediate metallic conduit.
RMC Rigid metallic conduit.

3.3 INSTALLATION OF SUPPORTS

A. Comply with NECA NEIS 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA NEIS 1, EMT, IMC, and RMC may be supported by openings through structure members, in accordance with NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination must be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.

2. To New Concrete: Bolt to concrete inserts.

3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

4. To Existing Concrete: Expansion anchor fasteners.

5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inch thick or

greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inch thick.

6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts or Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69 Spring-tension clamps.

7. To Light Steel: Sheet metal screws.

8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.4 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.2/D1.2M. Submit welding certificates.

3.5 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inch larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use **3000 psi**, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base as follows:

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.6 PAINTING

A. Touchup:

1. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

    a. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

2. Comply with requirements in Section 099113 "Exterior Painting", Section 099123 "Interior Painting", and Section 099600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 26 0529

SECTION 26 0533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

A. Coordinate layout and installation of raceway and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

1.2 SUMMARY

A. Section Includes:

1. Type EMT-S raceways and elbows.
2. Type ENT raceways and fittings.
3. Type EPEC raceways and fittings.
4. Type ERMC-S raceways, elbows, couplings, and nipples.
5. Type FMC-S.
6. Type FMT raceways.
7. Type IMC raceways.
8. Type LFMC raceways.
9. Type PVC raceways and fittings.
10. Type RTRC-AG raceways and fittings.
11. Fittings for conduit, tubing, and cable.
12. Threaded metal joint compound.
13. Solvent cements.
14. Surface metal raceways and fittings.
15. Strut-type channel raceways and fittings.
16. Wireways and auxiliary gutters.
17. Metallic outlet boxes, device boxes, rings, and covers.
18. Nonmetallic outlet boxes, device boxes, rings, and covers.

19. Termination boxes.

20. Cabinets, cutout boxes, junction boxes, pull boxes, and miscellaneous enclosures.

21. Cover plates for device boxes.

22. Hoods for outlet boxes.

B. Related Requirements:

1. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" for nonmetallic underground conduit with conductors (Type NUCC).

2. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes, and underground utility construction.

3. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

4. Section 270543 "Underground Pathways and Structures for Communication Systems" for exterior communications duct banks, manholes, and underground utility construction.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Wireways and auxiliary gutters.

2. Surface metal raceways.

3. Surface nonmetallic raceways.

4. Floor boxes.

5. Cabinets, cutout boxes, and miscellaneous enclosures.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details. Show that floor boxes are located to avoid interferences and are structurally allowable. Indicate floor thickness at location where boxes are embedded in concrete floors and underfloor clearances where boxes are installed in raised floors.

C. Samples: For wireways, surface raceways, and floor boxes for colors and textures specified, 12 inch long.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Instructions:

1. For Type ERMC-S-PVC.

PART 2 - PRODUCTS

2.1 TYPE EMT-SS RACEWAYS AND ELBOWS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 797A and UL Category Control Number FJMX.

B. Stainless Steel Electrical Metal Tubing (EMT-SS) and Elbows:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Calconduit; Atkore International.

2. Material: Stainless steel.

3. Options:

a. Minimum Trade Size: trade size 3/4.

b. Colors: As indicated on Drawings.

2.2 TYPE EMT-S RACEWAYS AND ELBOWS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 797 and UL Category Control Number FJMX.

B. Steel Electrical Metal Tubing (EMT-S) and Elbows:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit; Atkore International.

b. Calconduit; Atkore International.

c. Emerson Electric Co.

d. Picoma; Zekelman Industries.

e. Republic Conduit; Nucor Corporation, Nucor Tubular Products.

f. Topaz Lighting & Electric.

g. Western Tube; Zekelman Industries.

h. Wheatland Tube; Zekelman Industries.

2. Material: Steel.

3. Options:

a. Exterior Coating: Zinc.

b. Interior Coating: Zinc.

c. Minimum Trade Size: trade size 3/4).

d. Colors: As indicated on Drawings.

2.3 TYPE ENT RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 1653 and UL Category Control Number FKHU.

B. Electrical Nonmetallic Tubing (ENT) and Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Products Division.

b. Cantex Inc.

c. JM Eagle; J-M Manufacturing Co., Inc.

2. Options:

a. Minimum Trade Size: trade size 3/4.

b. Fittings:

1) Mechanically Attached Fittings: UL 1653.

2) Solvent-Attached Fittings: UL 651.

2.4 TYPE EPEC RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 651A and UL Category Control Number EAZX.

B. Schedule 40 Electrical HDPE Underground Conduit (EPEC-40):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Blue Diamond Industries.

b. JM Eagle; J-M Manufacturing Co., Inc.

c. Petroflex North America.

d. Prysmian Cables and Systems; Prysmian Group North America.

e. Southwire Company.

2. Dimensional Specifications: Schedule 40.

3. Options:

a. Minimum Trade Size: trade size 3/4.

C. Schedule 80 Electrical HDPE Underground Conduit (EPEC-80):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Blue Diamond Industries.

b. JM Eagle; J-M Manufacturing Co., Inc.

c. Petroflex North America.

d. Prysmian Cables and Systems; Prysmian Group North America.

e. Southwire Company.

2. Dimensional Specifications: Schedule 80.

3. Options:

a. Minimum Trade Size: trade size 3/4.

2.5 TYPE ERMC-SS RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 6A and UL Category Control Number DYWV.

3. Options:

a. Protective Coating: Provide protective coating for direct burial.

b. Minimum Trade Size: trade size 3/4).

c. Colors: As indicated on Drawings.

B. Stainless Steel Electrical Rigid Metal Conduit (ERMC-SS), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Products Division.

b. Allied Tube & Conduit; Atkore International.

c. Calconduit; Atkore International.

d. Crouse-Hinds; Eaton, Electrical Sector.

e. Patriot Aluminum Products, LLC.

2. Material: Stainless steel.

3. Options:

a. Minimum Trade Size: trade size 3/4.

b. Colors: As indicated on Drawings.

2.6 TYPE ERMC-S RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 6 and UL Category Control Number DYIX.

B. Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Allied Tube & Conduit; Atkore International.
    b. Calconduit; Atkore International.
    c. Crouse-Hinds; Eaton, Electrical Sector.
    d. Killark; Hubbell Incorporated, Construction and Energy.
    e. Patriot Aluminum Products, LLC.
    f. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
    g. Topaz Lighting & Electric.
    h. Western Tube; Zekelman Industries.
    i. Wheatland Tube; Zekelman Industries.
2. Exterior Coating: Zinc.
3. Options:
    a. Interior Coating: Zinc.
    b. Minimum Trade Size: trade size 3/4).
    c. Colors: As indicated on Drawings.

C. PVC-Coated-Steel Electrical Rigid Metal Conduit (ERMC-S-PVC), Elbows, Couplings, and Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. ABB, Electrification Products Division.
    b. Bluesteel Services LLC.
    c. Calbond; Atkore International.
    d. KorKap; Robroy Industries.
    e. Perma-Cote; Robroy Industries.
    f. Plasti-Bond; Robroy Industries.
2. Additional Characteristics:
    a. Fittings for PVC-Coated Conduit:

1) Minimum coating thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

2) Conduit bodies must be Form 8 with an effective seal and a positive placement feature to ease and assure proper installation. Certified results confirming seal performance at 15 psig (positive) and 25 in. of mercury (vacuum) for 72 hours must be available. Conduit bodies must be supplied with plastic-encapsulated stainless steel cover screws.

3) Form 2 inch long or one pipe diameter long, whichever is less, PVC sleeve at openings of female fittings, except unions. Inside sleeve diameter must be matched to outside diameter of metal conduit.

4) PVC coating on the outside of conduit couplings must be protected from tool damage during installation.

5) Female threads on fittings and couplings must be protected by urethane coating.

6) Fittings must be from same manufacturer as conduit.

7) Beam clamps and U bolts must be formed and sized to fit outside diameter of coated conduit. Plastic-encapsulated nuts must cover the exposed portions of threads.

3. Options:

a. Exterior Coating: PVC complying with NEMA RN 1 and marked ETL Verified PVC-001.

b. Interior Coating: Zinc.

c. Minimum Trade Size: trade size 3/4.

d. Colors: As indicated on Drawings.

e. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.

f. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

2.7 TYPE FMC-S RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 1 and UL Category Control Number DXUZ.

B. Steel Flexible Metal Conduit (FMC-S):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Products Division.

b. Electri-Flex Company.

c. Topaz Lighting & Electric.

2. Material: Steel.

3. Options:

a. Minimum Trade Size: [Metric designator 16 (trade size 1/2)] [Metric designator 21 (trade size 3/4)].

b. Colors: As indicated on Drawings.

4. Options:

a. Minimum Trade Size: trade size 3/4.

b. Colors: As indicated on Drawings.

2.8 TYPE FMT RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 1652 and UL Category Control Number ILJW.

B. Steel Flexible Metallic Tubing (FMT):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Electri-Flex Company.

b. International Metal Hose Co.

c. Liquid Tight Connector Co.

d. Southwire Company.

2. Options:

a. Minimum Trade Size: trade size 3/4.

b. Colors: As indicated on Drawings.

2.9 TYPE IMC RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 1242 and UL Category Control Number DYBY.

B. Steel Electrical Intermediate Metal Conduit (IMC):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Products Division.

b. Allied Tube & Conduit; Atkore International.

c. Calconduit; Atkore International.

d. Republic Conduit; Nucor Corporation, Nucor Tubular Products.

e. Topaz Lighting & Electric.

f. Western Tube; Zekelman Industries.

g. Wheatland Tube; Zekelman Industries.

2. Options:

a. Exterior Coating: Zinc.

b. Interior Coating: Zinc.

c. Minimum Trade Size: trade size 3/4.

d. Colors: As indicated on Drawings.

2.10 TYPE LFMC RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 360 and UL Category Control Number DXHR.

B. Steel Liquidtight Flexible Metal Conduit (LFMC-S):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ABB, Electrification Products Division.

    b. Anaconda Sealtite; Anamet Electrical, Inc.

    c. Electri-Flex Company.

    d. International Metal Hose Co.

2. Material: Steel.

3. Options:

    a. Minimum Trade Size: trade size 3/4.

    b. Colors: As indicated on Drawings.

2.11 TYPE PVC RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 651 and UL Category Control Number DZYR.

B. Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ABB, Electrification Products Division.

    b. Calconduit; Atkore International.

    c. JM Eagle; J-M Manufacturing Co., Inc.

    d. NAPCO; Westlake Chemical Corp.

    e. Opti-Com Manufacturing Network, Inc (OMNI).

    f. Topaz Lighting & Electric.

2. Dimensional Specifications: Schedule 40.

3. Options:

    a. Minimum Trade Size: trade size 3/4.

b. Markings: For use with maximum 90 deg C wire. For directional boring applications.

C. Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:

1. Dimensional Specifications: Schedule 80.

2. Options:

a. Minimum Trade Size: trade size 3/4.

b. Markings: For use with maximum 90 deg C wire. For directional boring applications.

D. Type EB Rigid PVC Concrete-Encased Underground Conduit (PVC-EB) and Fittings:

1. Dimensional Specifications: Type EB.

2. Options:

a. Minimum Trade Size: trade size 4".

2.12 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

B. Fittings for Type ERMC, Type IMC, Type PVC, Type EPEC, and Type RTRC Raceways:

1. General Characteristics: UL 514B and UL Category Control Number DWTT.

2. Options:

a. Material: Steel.

b. Coupling Method: Compression coupling, Raintight compression coupling with distinctive color gland nut.

c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.

d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

C. Fittings for Type EMT Raceways:

1. General Characteristics: UL 514B and UL Category Control Number FKAV.

2. Options:

a. Material: Steel.

b. Coupling Method: Compression coupling, Raintight compression coupling with distinctive color gland nut.

c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.

d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

D. Fittings for Type FMC Raceways:

1. General Characteristics: UL 514B and UL Category Control Number ILNR.

E. Fittings for Type LFMC and Type LFNC Raceways:

1. General Characteristics: UL 514B and UL Category Control Number DXAS.

2.13 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 2419 and UL Category Control Number FOIZ.

2.14 SOLVENT CEMENTS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: As recommended by conduit manufacturer in accordance with UL 514B and UL Category Control Number DWTT.

2.15 SURFACE METAL RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 5 and UL Category Control Number RJBT.

B. Surface Metal Raceways and Fittings with Metal Covers:

1. Options:

a. Galvanized steel base with snap-on covers.

b. Manufacturer's standard enamel finish in color selected by Architect Prime coated, ready for field painting.

c. Wiring Channels: Single, Dual, Triple. Multiple channels must be capable of housing a standard 20 to 30 A NEMA device flush within the raceway.

C. Surface Metal Raceways and Fittings with Nonmetallic Covers:

1. Additional Characteristics: UL 94, V-0 requirements for self-extinguishing characteristics.

2. Options:

a. **Galvanized steel** base with snap-on covers.

b. Provide texture and color selected by Architect from manufacturer's standard and custom colors.

c. Wiring Channels: Single, Dual, Triple. Multiple channels must be capable of housing a standard 20 to 30 A NEMA device flush within the raceway.

2.16 STRUT-TYPE CHANNEL RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 5B and UL Category Control Number RIUU.

B. Strut-Type Channel Raceways and Fittings with Metallic Covers:

1. Options:

a. [Manufacturer's standard enamel finish in color selected by Architect] [Prime coated, ready for field painting].

C. Strut-Type Channel Raceways and Fittings with Nonmetallic Covers:

1. Additional Characteristics: UL 94, V-0 requirements for self-extinguishing characteristics.

2. Options:

a. Provide texture and color selected by Architect from manufacturer's standard and custom colors.

2.17 WIREWAYS AND AUXILIARY GUTTERS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 870 and UL Category Control Number ZOYX.

B. Metal Wireways and Auxiliary Gutters:

1. Additional Characteristics:

a. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

b. Finish: Manufacturer's standard enamel finish.

2. Options:

a. Degree of Protection: Type 1, Type 3R, unless otherwise indicated.

b. Wireway Covers: Hinged type, Flanged-and-gasketed type unless otherwise indicated.

2.18 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 514A and UL Category Control Number QCIT.

B. Metallic Outlet Boxes:

1. Description: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.

2. Options:

a. Material: Sheet steel.

b. Sheet Metal Depth: Minimum 1.5 inch.

c. Cast-Metal Depth: Minimum 1.8 inch.

d. Luminaire Outlet Boxes and Covers: Nonadjustable, listed and labeled for attachment of luminaire weighing more than 50 lb. and marked with maximum allowable weight.

e. Paddle Fan Outlet Boxes and Covers: Nonadjustable, designed for attachment of paddle fan weighing up to 70 lb.

C. Metallic Conduit Bodies:

1. Description: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Products Division.

b. Crouse-Hinds; Eaton, Electrical Sector.

c. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.

d. Killark; Hubbell Incorporated, Construction and Energy.

e. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.

f. Pass & Seymour; Legrand North America, LLC.

g. Patriot Aluminum Products, LLC.

h. Plasti-Bond; Robroy Industries.

i. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.

j. Topaz Lighting & Electric.

D. Metallic Device Boxes:

1. Description: Box with provisions for mounting wiring device directly to box.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Products Division.

b. Arlington Industries, Inc.

c. Crouse-Hinds; Eaton, Electrical Sector.

d. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.

e. Hubbell Premise Wiring; Hubbell Incorporated, Commercial and Industrial.

f. Killark; Hubbell Incorporated, Construction and Energy.

g. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.

h. Patriot Aluminum Products, LLC.

i. Plasti-Bond; Robroy Industries.

j. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.

k. Topaz Lighting & Electric.

l. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

3. Options:

a. Material: Sheet steel.

b. Sheet Metal Depth: minimum 1.5 inch.

c. Cast-Metal Depth: minimum 1.8 inch.

E. Metallic Extension Rings:

1. Description: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Products Division.

b. B-line; Eaton, Electrical Sector.

c. Crouse-Hinds; Eaton, Electrical Sector.

d. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.

e. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.

f. Pass & Seymour; Legrand North America, LLC.

g. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.

h. Topaz Lighting & Electric.

i. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

F. Metallic Floor Boxes and Floor Box Covers:

1. Description: Box mounted in floor with floor box cover and other components to complete floor box enclosure.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ABB, Electrification Products Division.

    b. AFC Cable Systems; Atkore International.

    c. Arlington Industries, Inc.

    d. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

    e. FSR Inc.

    f. Hubbell Premise Wiring; Hubbell Incorporated, Commercial and Industrial.

    g. Leviton Manufacturing Co., Inc.

    h. Pass & Seymour; Legrand North America, LLC.

    i. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.

    j. Wiremold; Legrand North America, LLC.

    k. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

G. Metallic Recessed Access-Floor Boxes and Recessed Floor Box Covers:

1. Description: Floor box with provisions for mounting wiring devices below floor surface and floor box cover with provisions for passage of cords to recessed wiring devices mounted within floor box.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. FSR Inc.

    b. Wiremold; Legrand North America, LLC.

    c. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

H. Metallic Concrete Boxes and Covers:

1. Description: Box intended for use in poured concrete.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ABB, Electrification Products Division.

    b. Crouse-Hinds; Eaton, Electrical Sector.

    c. Hubbell Premise Wiring; Hubbell Incorporated, Commercial and Industrial.

d. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.

e. Topaz Lighting & Electric.

f. Wiremold; Legrand North America, LLC.

2.19 NONMETALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 514C and UL Category Control Number QCMZ.

B. Nonmetallic Outlet Boxes:

1. Description: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Products Division.

b. Allied Tube & Conduit; Atkore International.

c. Arlington Industries, Inc.

d. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

e. Cantex Inc.

f. Crouse-Hinds; Eaton, Electrical Sector.

g. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.

h. Ericson Manufacturing Company.

i. Hubbell Premise Wiring; Hubbell Incorporated, Commercial and Industrial.

j. Intermatic, Inc.

k. JM Eagle; J-M Manufacturing Co., Inc.

l. Leviton Manufacturing Co., Inc.

m. Panduit Corp.

n. Pass & Seymour; Legrand North America, LLC.

o. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.

p. Topaz Lighting & Electric.

q. Wiremold; Legrand North America, LLC.

r. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

C. Nonmetallic Conduit Bodies:

1. Description: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Products Division.

b. Allied Tube & Conduit; Atkore International.

c. Arlington Industries, Inc.

d. Cantex Inc.

e. JM Eagle; J-M Manufacturing Co., Inc.

f. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.

g. Topaz Lighting & Electric.

D. Nonmetallic Device Boxes:

1. Description: Box with provisions for mounting wiring device directly to box.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Products Division.

b. Allied Tube & Conduit; Atkore International.

c. Arlington Industries, Inc.

d. Cantex Inc.

e. Crouse-Hinds; Eaton, Electrical Sector.

f. Pass & Seymour; Legrand North America, LLC.

g. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.

h. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

E. Nonmetallic Extension Rings:

1. Description: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Products Division.

b. Allied Tube & Conduit; Atkore International.

c. Arlington Industries, Inc.

d. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

e. Cantex Inc.

f. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.

g. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

F. Nonmetallic Floor Boxes and Floor Box Covers:

1. Description: Box mounted in floor with floor box cover and other components to complete floor box enclosure.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Products Division.

b. Allied Tube & Conduit; Atkore International.

c. Arlington Industries, Inc.

d. Cantex Inc.

e. JM Eagle; J-M Manufacturing Co., Inc.

f. Pass & Seymour; Legrand North America, LLC.

g. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.

h. Wiremold; Legrand North America, LLC.

G. Nonmetallic Recessed Access-Floor Boxes and Recessed Floor Box Covers:

1. Description: Floor box with provisions for mounting wiring devices below floor surface and floor box cover with provisions for passage of cords to recessed wiring devices mounted within floor box.

H. Nonmetallic Floor Nozzles:

1. Description: Enclosure intended primarily as housing for receptacle, provided with means, such as collar, for surface-mounting on floor, which may or may not include stem to support it above floor level, and is sealed against the entrance of scrub water at floor level.

I. Nonmetallic Concrete Boxes and Covers:

1. Description: Box intended for use in poured concrete.

2.20 TERMINATION BOXES

A. Description: Enclosure for termination base consisting of lengths of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors or both.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 1773 and UL Category Control Number XCKT.

C. Termination Boxes and Termination Bases for Installation on Line Side of Service Equipment:

1. Additional Characteristics: Listed and labeled for installation on line side of service equipment.

D. ermination Boxes and Termination Bases for Installation on Load Side of Service Equipment:

1. Additional Characteristics: Listed and labeled for installation on load side of service equipment.

2.21 CABINETS, CUTOUT BOXES, JUNCTION BOXES, PULL BOXES, AND MISCELLANEOUS ENCLOSURES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics:

    a. Non-Environmental Characteristics: UL 50.

    b. Environmental Characteristics: UL 50E.

B. Indoor Sheet Metal Cabinets:

1. Description: Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.

2. Additional Characteristics: UL Category Control Number CYIV.

3. Options:

    a. Degree of Protection: Type 1, Type 12.

C. Indoor Sheet Metal Cutout Boxes:

1. Description: Enclosure that has swinging doors or covers secured directly to and telescoping with walls of enclosure.

2. Additional Characteristics: UL Category Control Number CYIV.

3. Options:

    a. Degree of Protection: **Type 1**.

D. Indoor Sheet Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.

2. Additional Characteristics: UL Category Control Number BGUZ.

3. Options:

    a. Degree of Protection: Type 1.

E. Indoor Cast-Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.

2. Additional Characteristics: UL Category Control Number BGUZ.

3. Options:

    a. Degree of Protection: Type 1.

F. Indoor Sheet Metal Miscellaneous Enclosures:

1. Additional Characteristics: UL 1773 and UL Category Control Number XCKT.

2. Options:

    a. Degree of Protection: Type 1.

G. Outdoor Sheet Metal Cabinets:

1. Description: Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.

2. Additional Characteristics: UL Category Control Number CYIV.

3. Options:

    a. Degree of Protection: Type 3R.

H. Outdoor Sheet Metal Cutout Boxes:

1. Description: Enclosure that has swinging doors or covers secured directly to and telescoping with walls of enclosure.

2. Additional Characteristics: UL Category Control Number CYIV.

3. Options:

    a. Degree of Protection: Type 3R.

I. Outdoor Sheet Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.

2. Additional Characteristics: UL Category Control Number BGUZ.

3. Options:

    a. Degree of Protection: Type 3R.

J. Outdoor Cast-Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.

2. Additional Characteristics: UL Category Control Number BGUZ.

3. Options:

    a. Degree of Protection: Type 3R.

K. Outdoor Sheet Metal Miscellaneous Enclosures:

1. Additional Characteristics: UL 1773 and UL Category Control Number XCKT.

2. Options:

    a. Degree of Protection: Type 3R.

2.22 COVER PLATES FOR DEVICES BOXES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics:

    a. Reference Standards: UL 514D and UL Category Control Numbers QCIT and QCMZ.

    b. Wallplate-Securing Screws: Metal with head color to match wallplate finish.

B. Metallic Cover Plates for Device Boxes:

1. Options:

    a. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.

    b. Wallplate Material: 0.032 inch thick Type 302/304 non-magnetic stainless steel with brushed finish, Steel with white baked enamel, suitable for field painting 0.04 inch thick steel with chrome-plated finish, Galvanized steel as indicated on architectural Drawings.

C. Nonmetallic Cover Plates for Device Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ABB, Electrification Products Division.

    b. Arlington Industries, Inc.

    c. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

    d. Crouse-Hinds; Eaton, Electrical Sector.

    e. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.

    f. Hubbell Premise Wiring; Hubbell Incorporated, Commercial and Industrial.

    g. Intermatic, Inc.

    h. Leviton Manufacturing Co., Inc.

i. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.

j. Panduit Corp.

k. Pass & Seymour; Legrand North America, LLC.

l. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.

m. Topaz Lighting & Electric.

n. Wiremold; Legrand North America, LLC.

o. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Options:

a. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.

b. Wallplate Material: 0.060 inch thick high-impact thermoplastic (nylon) with smooth finish and color matching wiring device as indicated on architectural Drawings.

c. Color: White or as indicated on architectural Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of the raceway system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 WIRING METHODS

A. Outdoors: Use 3/4” minimum trade size.

B. Indoors: use 3/4” minimum trade size except as noted below:

1. Connection to Vibrating Equipment Light Fixtures: 1/2” trade size minimum.

2. Connection to Light Fixtures: 1/2” trade size minimum, flexible metal conduit, except in wet or damp locations use Liquid tight flexible metal conduit, or solid connection.

C. Underground: use 1” minimum trade size.

3.3 SELECTION OF RACEWAYS

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of raceways. Consult Architect for resolution of conflicting requirements.

B. Outdoors:

1. Exposed and Subject to Severe Physical Damage: ERMC.

2. Exposed and Subject to Physical Damage: ERM. IMC, Corrosion-resistant EMT.

a. Locations less than 2.5 m (8 ft) above finished floor.

3. Exposed and Not Subject to Physical Damage: ERMC, Corrosion-resistant EMT, PVC-80.

4. Concealed Aboveground: ERMC, EMT.

5. Direct Buried: PVC-80, PVC-40.

6. Concrete Encased Not in Trench: PVC-80.

7. Concrete Encased in Trench: PVC-80.

8. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment**):** LFMC.

C. Indoors:

1. Hazardous Classified Locations: ERMC, IMC.

2. Exposed and Subject to Severe Physical Damage: ERMC. Subject to severe physical damage includes the following locations:

a. Loading docks.

b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.

c. Mechanical rooms.

d. Gymnasiums.

3. Exposed and Subject to Physical Damage: ERMC, IMC, EMT. Subject to physical damage includes the following locations:

a. Locations less than 2.5 m (8 ft) above finished floor.

b. Stub-ups to above suspended ceilings.

c.

4. Exposed and Not Subject to Physical Damage: ERMC, EMT, PVC-80.

5. Concealed in Ceilings and Interior Walls and Partitions: EMT.

6. Damp or Wet Locations: ERMC, IMC, Corrosion-resistant EMT.

7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment: LFMC.

D. Raceway Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.

1. ERMC and IMC: Provide threaded type fittings unless otherwise indicated.

3.4 SELECTION OF BOXES AND ENCLOSURES

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.

B. Degree of Protection:

1. Outdoors:

a. Type 3R unless otherwise indicated.

b. Locations Exposed to Hosedown: Type 4.

c. Locations Subject to Potential Flooding: Type 6P.

d. Locations Aboveground Where Mechanism Must Operate When Ice Covered: Type 3S.

e. Locations in-Ground or Exposed to Corrosive Agents: Type 6P, Type 3RX.

f. Locations in-Ground or Exposed to Corrosive Agents Where Mechanism Must Operate When Ice Covered: Type 3SX.

2. Indoors:

a. Type 1 unless otherwise indicated.

b. Damp or Dusty Locations: Type 12.

c. Surface Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: Type 12.

d. Flush Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: Type 12, Type 12K.

e. Locations Exposed to Airborne Dust, Lint, Fibers, or Flyings: Type 4, Type 6.

f. Locations Exposed to Hosedown: Type 4, Type 6.

g. Locations Exposed to Corrosive Agents: Type 4X.

h. Locations Exposed to Spraying Oil or Coolants: Type 13.

C. Exposed Boxes Installed Less Than 2.5 m (8 ft) Above Floor:

1. Provide cast-metal boxes. Boxes with knockouts or unprotected openings are prohibited.

2. Provide exposed cover. Flat covers with angled mounting slots or knockouts are prohibited.

3.5 INSTALLATION OF RACEWAYS

A. Installation Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for installation of raceways. Consult Architect for resolution of conflicting requirements.

2. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

3. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

4. Comply with NECA NEIS 101 for installation of steel raceways.

5. Comply with NECA NEIS 102 for installation of aluminum raceways.

6. Comply with NECA NEIS 111 for installation of nonmetallic raceways.

7. Install raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.

8. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to trade size 1-1/2 and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

9. Raceway Terminations at Locations Subject to Moisture or Vibration:

a. Provide insulating bushings to protect conductors, including conductors smaller than No. 4 AWG. Install insulated throat metal grounding bushings on service conductors.

B. General Requirements for Installation of Raceways:

1. Complete raceway installation before starting conductor installation.

2. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 ft. above finished floor.

3. Install no more than equivalent of three 90-degree bends in conduit run except for control wiring conduits, for which no more than equivalent of two 90-degree fewer bends are permitted. Support within 12 inch of changes in direction.

4. Make bends in raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.

5. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

6. Support conduit within 12 inch of enclosures to which attached.

7. Install raceway sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings in accordance with NFPA 70.

8. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of raceways at the following points:

    a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

    b. Where an underground service raceway enters a building or structure.

    c. Conduit extending from interior to exterior of building.

    d. Conduit extending into pressurized duct and equipment.

    e. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.

    f. Where otherwise required by NFPA 70.

9. Do not install raceways or electrical items on "explosion-relief" walls or rotating equipment.

10. Do not install conduits within 2 inch of the bottom side of a metal deck roof.

11. Keep raceways at least 6 inch away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

12. Cut conduit perpendicular to the length. For conduits metric designator 53 (trade size 2) and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.

13. Install pull wires in empty raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inch of slack at both ends of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

C. Requirements for Installation of Specific Raceway Types:

1. Types EMT-A, ERMC-A, and FMC-A:

a. Do not install aluminum raceways or fittings in contact with concrete or earth.

2. Types ERMC and IMC:

a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

3. Type ERMC-S-PVC:

a. Follow manufacturer's installation instructions for clamping, cutting, threading, bending, and assembly.

b. Provide PVC-coated sealing locknut for exposed male threads transitioning into female NPT threads that do not have sealing sleeves, including transitions from PVC couplings/female adapters to Type ERMC-S-PVC elbows in direct-burial applications. PVC-coated sealing locknuts must not be used in place of conduit hub. PVC-coated sealing locknut must cover exposed threads on Type ERMC-S-PVC raceway.

c. Coat field-cut threads on PVC-coated raceway with manufacturer-approved corrosion-preventing conductive compound prior to assembly.

4. Types FMC, LFMC, and LFNC:

a. Comply with NEMA RV 3. Provide a maximum of 72 inch of flexible conduit for **recessed and semi recessed luminaires,** equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

5. Types PVC and EPEC:

a. Do not install Type PVC or Type EPEC conduit where ambient temperature exceeds 122 deg F. Conductor ratings must be limited to 75 deg C except where installed in a trench outside buildings with concrete encasement, where 90 deg C conductors are permitted.

b. Comply with manufacturer's written instructions for solvent welding and fittings.

6. Type RTRC:

a. Do not install Type RTRC conduit where ambient temperature exceeds 230 deg F.

D. Raceways Embedded in Slabs:

1. Raceways in slabs will only be permitted if structural engineer allows the installation of any sized conduit on the. If allowed contractor will follow Structural Engineers requirements for size and installation.

2. If allowed run raceways larger than trade size 1 below concrete slab. Run raceways larger than trade size 1 parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place raceway close to slab support. Secure raceways to reinforcement at maximum 10 ft. intervals.

3. Arrange raceways to cross building expansion joints with expansion fittings at right angles to the joint.

4. Arrange raceways to ensure that each is surrounded by a minimum of 2 inch of concrete without voids.

5. Do not embed threadless fittings in concrete unless locations have been specifically approved by Architect.

6. Change from ENT to ER**MC** before rising above floor.

E. Stub-ups to Above Recessed Ceilings:

1. Provide EMT, IMC, or ERMC for raceways. Minimum 4" above slab.

2. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

F. Raceway Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.

1. ERMC-S-PVC: Provide only fittings listed for use with this type of conduit. Patch and seal joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Provide sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

2. EMT: Provide compression fittings. Comply with NEMA FB 2.10.

3. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.

G. Expansion-Joint Fittings:

1. Install in runs of aboveground PVC that are located where environmental temperature change may exceed 30 deg F and that have straight-run length that exceeds 25 ft. Install in runs of aboveground ERMC and EMT conduit that are located where environmental temperature change may exceed 100 deg F and that have straight-run length that exceeds 100 ft.

2. Install type and quantity of fittings that accommodate temperature change listed for the following locations:

a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.

b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.

c. Indoor Spaces Connected with Outdoors without Physical Separation: 25 deg F temperature change.

d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg. F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg. F of temperature change for metal conduits.

4. Install expansion fittings at locations where conduits cross building or structure expansion joints.

5. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

H. Raceways Penetrating Rooms or Walls with Acoustical Requirements:

1. Seal raceway openings on both sides of rooms or walls with acoustically rated putty or firestopping.

3.6 INSTALLATION OF SURFACE RACEWAYS

A. Install surface raceways only where indicated on Drawings.

B. Install surface raceway with a minimum 2 inch radius control at bend points.

C. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inch and with no less than two supports per straight raceway section. Support surface raceway in accordance with manufacturer's written instructions. Tape and glue are unacceptable support methods.

3.7 INSTALLATION OF BOXES AND ENCLOSURES

A. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.

B. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.

C. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box, whether installed indoors or outdoors.

D. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

E. Locate boxes so that cover or plate will not span different building finishes.

F. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.

G. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.

H. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.

I. Set metal floor boxes level and flush with finished floor surface.

J. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

K. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.

L. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.

M. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:

1. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.

2. Provide gaskets for wallplates and covers.

3.8 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.9 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer.

B. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.10 CLEANING

A. Upon completion of installation of system, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

B. Boxes: Remove construction dust and debris from device boxes, outlet boxes, and floor-mounted enclosures before installing wallplates, covers, and hoods.

END OF SECTION 26 0533

SECTION 26 0536 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 CABLE INSTALLATION

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Architect not less than two days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Architect’s written permission

1.2 SUMMARY

A. Section Includes:

1. Ladder cable tray.

2. Wire-mesh cable tray.

3. Cable tray accessories.

4. Warning signs.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

3. Section 270536 "Cable Trays for Communications Systems" for cable trays and accessories serving communications systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

   a. Vertical and horizontal offsets and transitions.

   b. Clearances for access above and to sides of cable trays.

   c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.

   d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Delegated Design Submittal: For seismic restraints.

1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer who is licensed in the state where Project is located and who is responsible for their preparation.

2. Design Calculations: Calculate requirements for selecting seismic restraints.

3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified structural professional engineer to design cable tray supports and seismic bracing.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAY

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles on individual cable tray types for specific values for the following parameters:

1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.

2. Concentrated Load: A load applied at midpoint of span and centerline of tray.

3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 LADDER CABLE TRAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB (Electrification Products Division).

2. Atkore International (Cope).

3. B-line; Eaton, Electrical Sector.

4. Chalfant Manufacturing Company.

5. MonoSystems, Inc.

6. MP Husky USA Cable Tray & Cable Bus.

7. Niedax Inc.

B. Description:

1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.

2. Width: 18 inch unless otherwise indicated on Drawings.

3. Minimum Usable Load Depth: 4 inch.

4. Straight Section Lengths: 10 ft, except where shorter lengths are required to facilitate tray assembly.

5. Rung Spacing: 6 inch on center.

6. Radius-Fitting Rung Spacing: 9 inch at center of tray's width.

7. Minimum Cable-Bearing Surface for Rungs: 7/8 inch width with radius edges.

8. No portion of the rungs must protrude below the bottom plane of side rails.

9. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200 lb. concentrated load, when tested according to NEMA VE 1.

10. Fitting Minimum Radius: 12 inch.

11. Class Designation: Comply with NEMA VE 1, Class 5A.

12. Splicing Assemblies: Bolted type using serrated flange locknuts.

13. Splice-Plate Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.

14. Covers: No cover required unless indicated on plans. If required provide Ventilated-hat type made of same materials and with same finishes as cable tray.

C. Materials and Finishes:

1. Steel:

a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A1011/A1011M, SS, Grade 33.

b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.

c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.

d. Finish:

1) Hot-dip galvanized after fabrication, complying with ASTM A123/A123M, Class B2, with galvanized, ASTM B633 hardware.
2) Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F1136.
3) Black oxide finish for support accessories and miscellaneous hardware according to ASTM D769.

2. Stainless Steel:

a. Materials: Low-carbon, passivated stainless steel, Type 316L, ASTM F593 and ASTM F594.

b. Hardware for Stainless Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

2.4 WIRE-MESH CABLE TRAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Atkore International (Cope).

2. B-line; Eaton, Electrical Sector.

3. Cablofil; Legrand North America, LLC.

4. Chalfant Manufacturing Company.

5. Enduro Composites Inc.

6. MonoSystems, Inc.

7. MP Husky USA Cable Tray & Cable Bus.

8. Niedax Inc.

9. Snaketray.

10. Vutec Corporation.

11. WBT LLC.

12. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

B. Description:

1. Configuration: Galvanized-steel wire mesh, complying with NEMA VE 1.

2. Width: 18 inch unless otherwise indicated on Drawings.

3. Minimum Usable Load Depth: 4 inch unless otherwise indicated on Drawings.

4. Straight Section Lengths: 10 ft., except where shorter lengths are required to facilitate tray assembly.

5. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200 lb. concentrated load, when tested according to NEMA VE 1.

6. Class Designation: Comply with NEMA VE 1, Class 5A.

7. Splicing Assemblies: Bolted type using serrated flange locknuts.

8. Splice-Plate Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.

C. Materials and Finishes:

1. Steel:

a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A1011/A1011M, SS, Grade 33.

b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.

c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.

d. Finish:

1) Hot-dip galvanized after fabrication, complying with ASTM A123/A123M, Class B2, with galvanized, ASTM B633 hardware.
2) Electrogalvanized after fabrication, complying with ASTM B633, with galvanized, ASTM B633 hardware.
3) Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F1136.
4) Black oxide finish for support accessories and miscellaneous hardware according to ASTM D769.

2.5 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.6 WARNING SIGNS

A. Lettering: 1-1/2 inch high, black letters on yellow background, with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."

B. Comply with Section 260553 "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA FG 1.

PART 3 - EXECUTION

3.1 INSTALLATION OF CABLE TRAY

A. Install cable tray level and plumb according to manufacturer’s written instructions, Coordination Drawings, original design, and reference standards.

B. Install cable tray and support systems according to NEMA FG 1.

C. Install cable tray as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

D. Install cable tray, so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

E. Remove burrs and sharp edges from cable trays.

F. Join aluminum cable tray with splice plates; use four square-neck carriage bolts and locknuts.

G. Fasten cable tray supports to building structure and install seismic restraints.

H. Design fasteners and supports to carry cable tray, installed cables, and a concentrated load of 200 lb. minimum and manufacturer’s recommendations. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems**."** Comply with seismic-restraint details according to Section 260548 "Seismic Controls for Electrical Systems."

I. Place supports, so that spans do not exceed maximum spans on schedules, and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of tray rungs.

J. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

K. Support assembly to prevent twisting from eccentric loading.

L. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.

M. Do not install more than one cable tray splice between supports.

N. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

O. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed recommended dimensions. Space connectors and set gaps according to applicable standard.

P. Make changes in direction and elevation using manufacturer's recommended fittings.

Q. Make cable tray connections using manufacturer's recommended fittings.

R. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

S. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

T. Install cable trays with enough workspace to permit access for installing cables.

U. Install barriers to separate cables of different systems, such as power, communications, and data processing, or of different insulation levels, such as 600, 5000, and 15 000 V.

V. Clamp covers on cable trays installed outdoors with heavy-duty clamps.

W. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to manufacturer's instructions.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 586A and UL 486B.

B. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

C. Cable trays with electrical power conductors must be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

D. Cable trays with single-conductor power conductors must be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72 inch intervals. The grounding conductor must be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

E. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding-bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

F. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 INSTALLATION OF CABLES

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every 18 inch.

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables

independent of the enclosure. The cable length between cable trays or between cable tray and enclosure must be no more than 72 inch.

E. Tie mineral-insulated cables down every 36 inch where required to provide a two-hour fire rating and every 72 inch elsewhere.

F. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

A. Anchorage: Test pullout resistance for toggle bolts and power-driven threaded studs for each type and size of anchorage material.

1. Furnish equipment, including jacks, jigs, fixtures, and calibrated indicating scales, required for reliable testing.

2. Obtain Architect's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener.

B. Tests and Inspections:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.

2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.

3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.

4. Verify that there are no intruding items, such as pipes, hangers, or other equipment, in the cable tray.

5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.

6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.

7. Check for improperly sized or installed bonding jumpers.

8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.

9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

C. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and must remain in place until the risk of damage is over.

2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 26 0536

SECTION 26 0543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings, including GRC and PVC-coated steel conduit.
2. Rigid nonmetallic duct.
3. Flexible nonmetallic duct.
4. Duct accessories.
5. Precast concrete handholes.
6. Polymer concrete handholes and boxes with polymer concrete cover.
7. Fiberglass handholes and boxes with polymer concrete cover.
8. Fiberglass handholes and boxes.
9. High-density plastic boxes.
10. Precast manholes.
11. Cast-in-place manholes.
12. Utility structure accessories.

1.3 DEFINITIONS

A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.

B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

C. Duct Bank:

1. Two or more ducts installed in parallel, with or without additional casing materials.

2. Multiple duct banks.

D. GRC: Galvanized rigid (steel) conduit.

E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include duct-bank materials, including spacers and miscellaneous components.

2. Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.

3. Include accessories for manholes, handholes, boxes, and other utility structures.

4. Include underground-line warning tape.

5. Include warning planks.

B. Shop Drawings:

1. Precast or Factory-Fabricated Underground Utility Structures:

a. Include plans, elevations, sections, details, attachments to other work, and accessories.

b. Include duct entry provisions, including locations and duct sizes.

c. Include reinforcement details.

d. Include frame and cover design and manhole chimneys.

e. Include [ladder] [step] details.

f. Include grounding details.

g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.

h. Include joint details.

2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.

b. Include duct entry provisions, including locations and duct sizes.

c. Include cover design.

d. Include grounding details.

e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For duct and duct bank. Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

2. Drawings shall be signed and sealed by a qualified professional engineer.

B. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.

C. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C858.

D. Source quality-control reports.

E. Field quality-control reports.

1.6 MAINTENANCE MATERIALS SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

1.8 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without Architect and Owner's written permission.

B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

C. Ground Water: Assume ground-water level is 36 inches below ground surface unless a higher water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND FITTINGS

A. GRC: Comply with ANSI C80.1 and UL 6.

B. Coated Steel Conduit: PVC-coated GRC, IMC.

1. Comply with NEMA RN 1.

2. Coating Thickness: 0.040 inch, minimum.

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB (Electrification Products Division).

2. Anamet Electrical, Inc (Anaconda Sealtite).

3. Appleton - O-Z/Gedney; Emerson Electric Co., Automation Solutions.

4. Atkore International (AFC Cable Systems).

5. Atkore International (Allied Tube & Conduit).

6. Atkore International (Calconduit).

7. Champion Fiberglass, Inc.

8. Electri-Flex Company.

9. FSR Inc.

10. Korkap.

11. NEC, Inc.

12. NewBasis.

13. Opti-Com Manufacturing Network, Inc (OMNI).

14. Patriot Aluminum Products, LLC.

15. Perma-Cote.

16. Plasti-Bond.

17. Republic Conduit.

18. Southwire Company.

19. Topaz Lighting & Electric.

20. Western Tube and Conduit Corporation.

21. Wheatland Tube Company.

22. Zekelman Industries (Picoma).

D. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 RIGID NONMETALLIC DUCT

A. Underground Plastic Utilities Duct: Type EPC-80-PVC and RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ARNCO Corp.

2. Beck Manufacturing.

3. Cantex Inc.

4. CertainTeed Corporation.

5. Condux International, Inc.

6. Crown Line Plastics.

7. ElecSys, Inc.

8. Electri-Flex Company.

9. Endot Industries Inc.

10. IPEX USA LLC.

11. Lamson & Sessions.

12. Manhattan/CDT.

13. National Pipe & Plastics.

14. Opti-Com Manufacturing Network, Inc (OMNI).

15. Spiraduct/AFC Cable Systems, Inc.

C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

D. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 DUCT ACCESSORIES

A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Atkore International (Allied Tube & Conduit).

b. Cantex Inc.

c. Carlon; a brand of Thomas & Betts Corporation.

d. IPEX USA LLC.

e. PenCell Plastics.

f. Underground Devices, Inc.

B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

C. Concrete Warning Planks: Nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi concrete.

1. Color: Red dye added to concrete during batching.

2. Mark each plank with "ELECTRIC" in 2-inch-high, 3/8-inch-deep letters.

2.4 PRECAST CONCRETE HANDHOLES AND BOXES

A. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Christy Concrete Products.
2. Elmhurst-Chicago Stone Co.
3. Oldcastle Precast, Inc.
4. Rinker Group, Ltd.
5. Riverton Concrete Products.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.
8. Wausau Tile Inc.

C. Comply with ASTM C858 for design and manufacturing processes.

D. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

E. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

F. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.

1. Cover Hinges: Concealed, with hold-open ratchet assembly.
2. Cover Handle: Recessed.

G. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.

1. Cover Hinges: Concealed, with hold-open ratchet assembly.
2. Cover Handle: Recessed.

H. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

I. Cover Legend: Molded lettering, "ELECTRIC" or as indicated for each service.

J. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

K. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

L. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

1. Splayed Center window] location.

2. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.

3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.

4. Knockout panels shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.

5. Knockout panels shall be 1-1/2 to 2 inches thick.

M. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

1. Type and size shall match fittings to duct to be terminated.

2. Fittings shall align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.

N. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.5 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armorcast Products Company.

2. MacLean Highline.

3. NewBasis.

4. Oldcastle Enclosure Solutions.

5. Quazite; Hubbell Incorporated, Power Systems.

C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

D. Color: Gray.

E. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

H. Cover Legend: Molded lettering, "ELECTRIC" or as indicated for each service.

I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

K. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.6 PRECAST MANHOLES

A. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carder Concrete Products.
2. Christy Concrete Products.
3. Elmhurst-Chicago Stone Co.
4. Oldcastle Precast, Inc.
5. Rinker Group, Ltd.
6. Riverton Concrete Products.
7. Utility Concrete Products, LLC.
8. Utility Vault Co.
9. Wausau Tile Inc.

C. Comply with ASTM C858.

D. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.

E. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

1. Splayed Center window location.

2. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.

3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.

4. Knockout panel shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.

5. Knockout panels shall be 1-1/2 to 2 inches thick.

F. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

1. Type and size shall match fittings to duct to be terminated.

2. Fittings shall align with elevations of approaching duct and be located near interior corners of manholes to facilitate racking of cable.

G. Ground Rod Sleeve: Provide a 3-inch PVC sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the duct entering the structure.

H. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.7 CAST-IN-PLACE MANHOLES

A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for duct entrance and sleeve for ground rod.

B. Materials: Comply with ASTM C858 and with Section 033000 "Cast-in-Place Concrete."

C. Structural Design Loading: As specified in "Underground Enclosure Application" Article.

2.8 UTILITY STRUCTURE ACCESSORIES

A. Accessories for Utility Structures: Utility equipment and accessory items used for utility structure access and utility support, listed and labeled for intended use and application.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. BILCO Company (The).
2. Campbell Foundry Company.
3. Carder Concrete Products.
4. Christy Concrete Products.
5. EJ.
6. Elmhurst-Chicago Stone Co.
7. McKinley Iron Works, Inc.
8. Neenah Foundry Company.
9. NewBasis.
10. Oldcastle Precast, Inc.
11. Osburn Associates, Inc.
12. Pennsylvania Insert Corporation.
13. Quazite; Hubbell Incorporated, Power Systems.
14. Rinker Group, Ltd.
15. Riverton Concrete Products.
16. Underground Devices, Inc.
17. Utility Concrete Products, LLC.
18. Utility Vault Co.
19. Wausau Tile Inc.

C. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.

1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A48/A48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 26 inches.

    a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

    b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.

2. Cover Legend: Cast in. Selected to suit system.

    a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.

    b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.

3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.

    a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C387, Type M, may be used.

    b. Seal joints watertight using preformed plastic or rubber complying with ASTM C990. Install sealing material according to sealant manufacturers' written instructions.

D. Manhole Sump Frame and Grate: ASTM A48/A48M, Class 30B, gray cast iron.

E. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-diameter eye, and 1-by-4-inch bolt.

1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.

F. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch-diameter eye, rated 2500-lbf minimum tension.

G. Pulling-in and Lifting Irons in Concrete Floors: 7/8-inch-diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.

1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

H. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.

1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

I. Ground Rod Sleeve: 3-inch PVC sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the ducts routed from the facility.

J. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

K. Cable Rack Assembly: Steel, hot-rolled galvanized, except insulators.

1. Stanchions: T-section or channel with provisions to connect to other sections or channels to form a continuous unit; 1-1/2 inches in width by nominal 24 inches long; punched with 14 hook holes on 1-1/2-inch centers for cable-arm attachment.

2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.

3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

L. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.

1. Stanchions: Nominal 36 inches high by 4 inches wide, with provisions to connect to other sections to form a continuous unit, with minimum of nine holes for arm attachment.

2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.

M. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduit, conduit and duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

N. Fixed Manhole Ladders: Arranged for attachment to roof or wall and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, hot-dip galvanized steel.

O. Cover Hooks: Heavy duty, designed for Light duty, designed for lifts less than 60 lbf. Two required.

2.9 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.

2. Strength tests of complete boxes and covers shall be by an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.

C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

3.2 UNDERGROUND DUCT APPLICATION

A. Duct for Electrical Cables More Than 600 V: Type EPC-80-PVC concrete-encased unless otherwise indicated.

B. Duct for Electrical Feeders 600 V and Less: Type EPC-80-PVC, RNC, concrete-encased unless otherwise indicated.

C. Duct for Electrical Feeders 600 V and Less: Type EPC-80-PVC, RNC, direct-buried unless otherwise indicated.

D. Duct for Electrical Branch Circuits: Type EPC-80-PVC, RNC, direct-buried unless otherwise indicated.

E. Bored Underground Duct: Type EPEC-80-HDPE unless otherwise indicated.

F. Underground Ducts Crossing Paved Paths, Driveways, and Roadways: Type EPC-80 PVC RNC, encased in reinforced concrete.

G. Stub-ups: Concrete-encased GRC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.

2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20, Polymer concrete, SCTE 77, Tier 22, structural load rating.

3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-20, Polymer concrete units, SCTE 77, Tier 15 structural load rating.

4. Cover design load shall not exceed the design load of the handhole or box.

B. Manholes: Precast or cast-in-place concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.

2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.4 EARTHWORK

A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Replace area immediately after backfilling is completed or after construction vehicle traffic in immediate area is complete.

C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."

E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to "Cutting and Patching" Article in Section 017300 "Execution."

3.5 DUCT AND DUCT-BANK INSTALLATION

A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.

B. Install duct according to NEMA TCB 2.

C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.

D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 12.5 feet, both horizontally and vertically, at other locations unless otherwise indicated.

1. Duct shall have maximum of two 90 degree bends or the total of all bends shall be no more 180 degrees between pull points.

E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.

F. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.

G. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch duct, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell, without reducing duct slope and without forming a trap in the line.

2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct with calculated expansion of more than 3/4 inch.

3. Grout end bells into structure walls from both sides to provide watertight entrances.

H. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to terminator spacing 10 feet from the terminator, without reducing duct line slope and without forming a trap in the line.

2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line duct with calculated expansion of more than 3/4 inch.

I. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

J. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

K. Pulling Cord: Install 200-lbf-test nylon cord in empty ducts.

L. Concrete-Encased Ducts and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches in nominal diameter.

2. Width: Excavate trench 12 inches wider than duct on each side.

3. Width: Excavate trench 3 inches wider than duct on each side.

4. Depth: Install so top of duct envelope is at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.

5. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.

6. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than **four** spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

7. Minimum Space between Duct: 3 inches between edge of duct and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and communications ducts.

8. Elbows: Use manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.

9. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.

   a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.

   b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

      1) Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.

   c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.

      1) Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of slab.

10. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

11. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

12. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between duct of like services, and 4 inches between power and communications ducts.

13. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written instructions, or use other specific measures to prevent expansion-contraction damage.

    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.

14. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

M. Direct-Buried Duct and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inches in nominal diameter.

2. Width: Excavate trench 12 inches wider than duct on each side.

3. Width: Excavate trench 3 inches wider than duct on each side.

4. Depth: Install top of duct at least 36 inches below finished grade unless otherwise indicated.

5. Set elevation of bottom of duct bank below frost line.

6. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.

7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four five spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth

and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

8. Install duct with a minimum of 3 inches between ducts for like services and 6 inches between power and communications duct.

9. Elbows: Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

10. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.

    a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.

    b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.

    c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of slab.

11. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.

    a. Place minimum 3 inches of sand as a bed for duct. Place sand to a minimum of 6 inches above top level of duct.

    b. Place minimum 6 inches of engineered fill above concrete encasement of duct.

N. Warning Planks: Bury warning planks approximately 12 inches above direct-buried duct, placing them 24 inches o.c. Align planks along the width and along the centerline of duct or duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.

O. Underground-Line Warning Tape: Bury conducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inches above all

concrete-encased duct and duct banks and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:

1. Finish interior surfaces with a smooth-troweled finish.

2. Knockouts for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.

3. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.

B. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C891 unless otherwise indicated.

2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.

3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.

2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.

3. Install handholes with bottom below frost line, at Project site below grade.

4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.

5. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.

2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.

F. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Section 071353 "Elastomeric Sheet Waterproofing." Section 071354 "Thermoplastic Sheet Waterproofing." After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

G. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 071113 "Bituminous Dampproofing." After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

H. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

I. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

J. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below frost line, at Project site below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi, 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with a troweled finish.

2. Dimensions: **12 inches wide by 12 inches deep**.

3.8 GROUNDING

A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.

2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch-long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.

3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Prepare test and inspection reports.

3.10 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump.

1. Sweep floor, removing dirt and debris.

2. Remove foreign material.

END OF SECTION 26 0543

SECTION 26 0544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Round sleeves.
2. Rectangular sleeves.
3. Sleeve seal systems.
4. Grout.
5. Pourable sealants.
6. Foam sealants.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

A. Wall Sleeves, Steel:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Advance Products & Systems, LLC.

    b. CCI Piping Systems.

    c. Flexicraft Industries.

    d. GPT; an EnPro Industries company.

    No manufacturers available

2. Description: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

B. Wall Sleeves, Cast Iron:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. American Ductile Iron Pipe.

    b. Flexicraft Industries.

    c. McWane Ductile.

2. Description: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.

C. Pipe Sleeves, PVC:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. CCI Piping Systems.

    b. GPT; an EnPro Industries company.

    c. Metraflex Company (The).

2. Description: ASTM D1785, Schedule 40.

D. Molded Sleeves, PVC:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ABB, Electrification Products Division.

    b. Arlington Industries, Inc.

c. Reliance Worldwide Corporation.

2. Description: With nailing flange for attaching to wooden forms.

E. Molded Sleeves, PE or PP:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crete-Sleeve.

2. Description: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sheet Metal Sleeves, Galvanized Steel, Round:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Benefast.

b. Specified Technologies, Inc.

2. Description: Galvanized-steel sheet; thickness not less than 0.0239 inch; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 RECTANGULAR SLEEVES

A. Sheet Metal Sleeves, Galvanized Steel, Rectangular:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Abesco Fire LLC.

b. Specified Technologies, Inc.

c. Wiremold; Legrand North America, LLC.

2. Description:

a. Material: Galvanized sheet steel.

b. Minimum Metal Thickness:

1) For sleeve cross-section rectangle perimeter less than 50 inch and with no side larger than 16 inch, thickness must be 0.052 inch.

2) For sleeve cross-section rectangle perimeter not less than 50 inch or with one or more sides larger than 16 inch, thickness must be 0.138 inch.

2.3 SLEEVE SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.

2. BWM Company.

3. CALPICO, Inc.

4. Flexicraft Industries.

5. Metraflex Company (The).

6. Pipeline Seal and Insulator, Inc.

7. Proco Products, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.

1. Sealing Elements: EPDM, Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

2. Pressure Plates: Carbon steel.

3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.4 GROUT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. W.R. Meadows, Inc.

B. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

2. Design Mix: 5000 psi, 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

2.5 POURABLE SEALANTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carlisle SynTec Incorporated.

2. GAF.

3. Johns Manville; a Berkshire Hathaway company.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.

b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide 1/4 inch annular clear space between sleeve and raceway or cable, unless sleeve seal system is to be installed or seismic criteria require different clearance.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

5. Install sleeves for floor penetrations. Extend sleeves installed in floors 4 inch above finished floor level. Install sleeves during erection of floors.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

2. Seal space outside of sleeves with approved joint compound for wall assemblies.

C. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seal systems. Size sleeves to allow for 1 inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

E. Underground, Exterior-Wall and Floor Penetrations:

1. Install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve seal system. Install sleeve during construction of floor or wall.

2. Install steel pipe sleeves. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve seal system. Grout sleeve into wall or floor opening.

3.2 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.

B. Install conduits and cable with no crossings within the sleeve.

C. Fill opening around conduits and cables with expanding foam without leaving voids.

D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.3 INSTALLATION OF SLEEVE SEAL SYSTEMS

A. Install sleeve seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION 26 0544

SECTION 26 0548.16 - SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Restraints - rigid type.

2. Restraints - cable type.

3. Restraint accessories.

4. Post-installed concrete anchors.

5. Concrete inserts.

B. Related Requirements:

1. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.2 DEFINITIONS

A. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

1.3 COORDINATION

A. Tests and Inspections:

1. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and provide notice at least seven days in advance.

2. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load capacity for each seismic and wind-load restraint device.

2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic and wind-load restraint component used.

3. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by an agency acceptable to authorities having jurisdiction.

4. Annotate to indicate application of each product submitted and compliance with requirements.

B. Delegated Design Submittal, signed and sealed by qualified structural professional engineer, for Each Seismic-Restraint Device:

1. For each seismic-restraint device, including restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on Drawings, submit the following:

a. Seismic Restraints: Select seismic restraints complying with performance requirements, design criteria, and analysis data.

b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by an NRTL for seismic reinforcement use.

C. Delegated Design Submittal: Signed and sealed by qualified structural professional engineer, for each wind-load protection device.

1. For each wind-load protection device, including restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on Drawings, submit the following:

a. Wind-Load Restraint: Select wind-load restraints complying with performance requirements, design criteria, and analysis data.

b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated wind loads. Include certification that device is approved by an NRTL for reinforcement use.

c. Wind-Load Design Calculations: Submit static and dynamic loading calculations.

2. Seismic and Wind-Load-Restraint Detail Drawings prepared by qualified structural professional engineer:

a. Design Analysis: To support selection and arrangement of seismic and wind-load restraints. Include calculations of combined tensile and shear loads.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

c. Coordinate seismic-restraint details with wind-load details required for equipment mounted outdoors.

3. Product Listing, Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic and wind-load bracing for components with other systems and equipment in the vicinity, including other supports and seismic restraints.

B. Welding certificates.

C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic and Wind-Load-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by an agency acceptable to authorities having jurisdiction.

B. Consequential Damage: Provide additional seismic and wind-load restraints for suspended components or anchorage of floor-, roof-, or wall-mounted components so that failure of a non-essential or essential component does not cause failure of any other essential building component.

C. Fire/Smoke Resistance: Seismic and wind-load-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested and labeled by an NRTL in accordance with ASTM E84 or UL 723.

D. Component Supports:

1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of an NRTL.

2.2 RESTRAINTS - RIGID TYPE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line; Eaton, Electrical Sector.

2. CADDY; nVent.

3. California Dynamics Corporation.

4. Hilti, Inc.

5. Isolation Technology, Inc.

6. TOLCO.

7. Unistrut; Atkore International.

8. Vibration Mountings & Controls, Inc.

B. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.3 RESTRAINTS - CABLE TYPE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line; Eaton, Electrical Sector.

2. CADDY; nVent.

3. Loos & Co.

4. Vibration Mountings & Controls, Inc.

B. Seismic and Wind-Load-Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

C. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. Cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.4 RESTRAINT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line; Eaton, Electrical Sector.

2. CADDY; nVent.

3. Hilti, Inc.

4. Loos & Co.

5. Mason Industries, Inc.

6. TOLCO.

7. Unistrut; Atkore International.

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.5 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. B-line; Eaton, Electrical Sector.

b. Hilti, Inc.

c. Mason Industries, Inc.

d. Powers Fasteners.

e. Simpson Strong-Tie Co., Inc.

f. Unistrut; Atkore International.

2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. B-line; Eaton, Electrical Sector.

b. Hilti, Inc.

c. Mason Industries, Inc.

d. Powers Fasteners.

e. Simpson Strong-Tie Co., Inc.

f. Unistrut; Atkore International.

2. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in seismic and wind-load applications.

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.

2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp that is not vibration isolated.

1. Undercut expansion anchors are permitted.

2.6 CONCRETE INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following

1. B-line; Eaton, Electrical Sector.

2. Hilti, Inc.

3. Mason Industries, Inc.

4. Powers Fasteners.

5. Simpson Strong-Tie Co., Inc.

6. Unistrut; Atkore International.

B. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC446 testing.

C. Comply with MSS SP-58.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive seismic and wind-load control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry static**,** wind-load, and seismic loads within specified loading limits.

3.3 INSTALLATION OF SEISMIC-RESTRAINT AND WIND-LOAD CONTROL DEVICES

A. Provide seismic-restraint and wind-load control devices for systems and equipment where indicated in Equipment Schedules or Seismic and Wind-Load Controls Schedule, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

1. Install equipment and devices to withstand the effects of earthquake motions and high wind events.

B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

C. Installation of seismic and wind-load restraints must not cause any stresses, misalignment, or change of position of equipment or conduits.

D. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

2. Install seismic-restraint and wind-load-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

E. Raceway, Cable, Wireway, Cable Tray, and Busway Support and Hanger Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

2. Install seismic-restraint and wind-load-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction] that provides required submittals for component.

F. Equipment and Hanger Restraints:

1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

G. Install cables so they do not bend across edges of adjacent equipment or building structure.

H. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

I. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

J. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors must be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in 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.

5. Set anchors to manufacturer's recommended torque using a torque wrench.

6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

A. Field tests must be witnessed by Architect and authorities having jurisdiction.

B. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

2. Test no fewer than four of each type and size of installed anchors and fasteners selected by Architect.

3. Test to 90 percent of rated proof load of device.

C. Seismic controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 26 0548

SECTION 26 0550 – INSTALLATION COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 REQUIREMENTS

A. See Division 21, Section 210549, Fire Protection and Electrical Installation Coordination.

B. See Division 22, Section 220549, Plumbing & Electrical Installation Coordination.

C. See Division 23, Section 230549, HVAC and Electrical Installation Coordination.

D. See Mechanical Drawings for control requirements and for items requiring 120V power.

PART 2 - PRODUCTS

A. Not applicable.

PART 3 - EXECUTION

A. Not applicable.

END OF SECTION 26 0550

SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Labels.

2. Bands and tubes.

3. Tapes and stencils.

4. Tags.

5. Signs.

6. Cable ties.

7. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

D. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer's Standard Products: Where more than one type is listed for a specified application, selection is Installer's option, but provide single type for each application category.

B. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, except as otherwise indicated, with eyelet for fastener.

C. Aluminum-Faced Card-Stock Tags: Weather-resistant, 18-point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 inch thick, laminated with moisture-resistant acrylic adhesive, and punched for the fastener. Preprinted legends suit each application.

2.2 ENGRAVED NAMEPLATES AND SIGNS

A. Engraved Legend:

1. Normal Power – White letters on black face, unless noted otherwise on Drawings.

2. Emergency Power – White letters on red face, unless noted otherwise on Drawings.

3. UPS Power – White letters on blue face, unless noted otherwise on Drawings.

2.3 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Comply with NFPA 70E and Section 260573 "Electrical Systems Studies" requirements for arc-flash warning labels.

F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.4 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.

2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase-and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

1. Color shall be factory applied[or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit].

2. Colors for 208/120-V Circuits:

a. Phase A: Black.

b. Phase B: Red.

c. Phase C: Blue.

3. Colors for 240-V Circuits:

a. Phase A: Black.

b. Phase B: Red.

4. Colors for 480/277-V Circuits:

a. Phase A: Brown.

b. Phase B: Orange.

c. Phase C: Yellow.

5. Color for Neutral: White 208V or gray 480V.

6. Color for Equipment Grounds: Green.

C. Raceways and Cables Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.

2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

D. Warning Label Colors:

1. Identify system voltage with black letters on an orange background.

E. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

F. Equipment Identification Labels:

1. Black letters on a white field.

2.5 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.

b. Champion America.

c. emedco.

d. Grafoplast Wire Markers.

e. HellermannTyton.

f. LEM Products Inc.

g. Marking Services, Inc.

h. Panduit Corp.

i. Seton Identification Products; a Brady Corporation company.

B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.

b. HellermannTyton.

c. Marking Services, Inc.

d. Panduit Corp.

e. Seton Identification Products; a Brady Corporation company.

C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, polyester flexible label with acrylic pressure-sensitive adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. A'n D Cable Products.

    b. Brady Corporation.

    c. Brother International Corporation.

    d. emedco.

    e. Grafoplast Wire Markers.

    f. Ideal Industries, Inc.

    g. LEM Products Inc.

    h. Marking Services, Inc.

    i. Panduit Corp.

    j. Seton Identification Products; a Brady Corporation company.

2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.

3. Marker for Labels:

    a. Permanent, waterproof, black ink marker recommended by tag manufacturer.

    b. Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Polyester, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. Minimum Nominal Size:

    a. 1-1/2 by 6 inches for raceway and conductors.

    b. 3-1/2 by 5 inches for equipment.

    c. As required by authorities having jurisdiction.

2.6 BANDS AND TUBES

A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Brady Corporation.

b. HellermannTyton.

c. Marking Services, Inc.

d. Panduit Corp.

B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.

b. Panduit Corp.

2.7 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Carlton Industries, LP.

b. Champion America.

c. HellermannTyton.

d. Ideal Industries, Inc.

e. Marking Services, Inc.

f. Panduit Corp.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.

b. Carlton Industries, LP.

c. emedco.

d. Marking Services, Inc.

C. Tape and Stencil: 4-inch-wide black stripes on 10-inch centers placed diagonally over orange background and are 12 inches wide. Stop stripes at legends.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brimar Industries, Inc.

b. HellermannTyton.

c. LEM Products Inc.

d. Marking Services, Inc.

e. Seton Identification Products; a Brady Corporation company.

D. Floor Marking Tape: 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Carlton Industries, LP.

b. Seton Identification Products; a Brady Corporation company.

E. Underground-Line Warning Tape:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.

b. Brimar Industries, Inc.

c. Ideal Industries, Inc.

d. LEM Products Inc.

e. Marking Services, Inc.

f. Reef Industries, Inc.

g. Seton Identification Products; a Brady Corporation company.

2. Tape:

a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.

b. Printing on tape shall be permanent and shall not be damaged by burial operations.

c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

3. Color and Printing:

a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.

b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".

c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".

4. Tape Type I:

a. Pigmented polyolefin, bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.

b. Width: 3 inches.

c. Thickness: 4 mils.

d. Weight: 18.5 lb/1000 sq. ft..

e. Tensile according to ASTM D882: 30 lbf and 2500 psi.

5. Tape Type II:

a. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.

b. Width: 3 inches.

c. Thickness: 12 mils.

d. Weight: 36.1 lb/1000 sq. ft..

e. Tensile according to ASTM D882: 400 lbf and 11,500 psi.

6. Tape Type ID:

a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.

b. Width: 3 inches.

c. Overall Thickness: 5 mils.

d. Foil Core Thickness: 0.35 mil.

e. Weight: 28 lb/1000 sq. ft..

f. Tensile according to ASTM D882: 70 lbf and 4600 psi.

7. Tape Type IID:

a. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.

b. Width: 3 inches.

c. Overall Thickness: 8 mils.

d. Foil Core Thickness: 0.35 mil.

e. Weight: 34 lb/1000 sq. ft..

f. Tensile according to ASTM D882: 300 lbf and 12,500 psi.

F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be **1 inch**.

2.8 TAGS

A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.

b. Carlton Industries, LP.

c. emedco.

d. Marking Services, Inc.

e. Seton Identification Products; a Brady Corporation company.

B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.023 inch thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.

b. Carlton Industries, LP.

c. emedco.

d. Grafoplast Wire Markers.

e. LEM Products Inc.

f. Marking Services, Inc.

g. Panduit Corp.

h. Seton Identification Products; a Brady Corporation company.

C. Write-on Tags:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brimar Industries, Inc.

b. Carlton Industries, LP.

c. LEM Products Inc.

d. Seton Identification Products; a Brady Corporation company.

2. Polyester Tags: 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment.

3. Marker for Tags:

a. Permanent, waterproof, black ink marker recommended by tag manufacturer.

b. Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.9 SIGNS

A. Baked-Enamel Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Carlton Industries, LP.

b. Champion America.

c. emedco.

d. Marking Services, Inc.

2. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.

3. 1/4-inch grommets in corners for mounting.

4. Nominal Size: 7 by 10 inches.

B. Metal-Backed Butyrate Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.

b. Champion America.

c. emedco.

d. Marking Services, Inc.

2. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.

3. 1/4-inch grommets in corners for mounting.

4. Nominal Size: 10 by 14 inches.

C. Laminated Acrylic or Melamine Plastic Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.

b. Carlton Industries, LP.

c. emedco.

d. Marking Services, Inc.

2. Engraved legend.

3. Thickness:

a. For signs up to 20 sq. in., minimum 1/16 inch thick.

b. For signs larger than 20 sq. in., 1/8 inch thick.

c. Engraved legend with black letters on white face.

d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.

e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.10 CABLE TIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. HellermannTyton.

2. Ideal Industries, Inc.

3. Marking Services, Inc.

4. Panduit Corp.

B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.

2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.

3. Temperature Range: Minus 40 to plus 185 deg F.

4. Color: Black, except where used for color-coding.

C. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.

2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.

3. Temperature Range: Minus 40 to plus 185 deg F.

4. Color: Black.

D. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch.

2. Tensile Strength at 73 Deg F according to ASTM D638: 7000 psi.

3. UL 94 Flame Rating: 94V-0.

4. Temperature Range: Minus 50 to plus 284 deg F.

5. Color: Black.

2.11 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Identify feeders over 600 V labeled with “DANGER—HIGH VOLTAGE” with black letters 2 inches high, stenciled with paint at 10-foot intervals over a continuous, painted orange background. Identify the following:

1. Entire surface of exposed conduits.

B. Install painted identification as follows:

1. Clean surfaces of dust, loose material, and oily films before painting.

2. Prime Surfaces: For galvanized metal, use single-component, acrylic vehicle coating formulated for galvanized surfaces. For concrete masonry units, use heavy-duty, acrylic-resin block filler. For concrete surfaces, use clear, alkali-resistant, alkyd binder-type sealer.

3. Apply one intermediate and one finish coat of silicone alkyd enamel.

4. Apply primer and finish materials according to manufacturer's instructions.

    a. Identify Raceways and Exposed Cables with Color Banding: Band exposed and accessible raceways of the systems listed below for identification.

5. Colors: As follows:

    a. 120/208 Volt – Black

    b. 277/480 Volt – Blue

    c. Emergency 120/208 Volt – Black and Orange

    d. Emergency 277/480 Volt – Blue and Orange

    e. Fire-Alarm System – Red

    f. Fire-Suppression Supervisory and Control System – Red and Yellow

    g. Combined Fire-Alarm and Security System – Red and Blue

    h. Security System – Blue and Yellow

    i. Mechanical and Electrical Supervisory System – Green and Blue

6. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.

7. Concealed Boxes: Plasticized cardstock tags.

8. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

C. Color-Code Conductors:

1. 208/120-V System: As follows:

    a. Neutral – White

    b. Ground – Green

2. 480-277-V System: As follows;

    a. Neutral – Grey

    b. Ground – Green

3. Factory-apply color the entire length of the conductors, except the following field-applied, color-coding methods may be used in lieu of factory-coded wire for phase conductors sizes larger than No. 10 AWG and grounded conductors and grounding conductors larger than No. 6 AWG.

a. Colored cable ties applied in groups of 3 ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.

4. Power Circuit Identification: Fasten bands using integral ears.

D. Apply identification to conductors as follows:

1. Conductors to be Extended in the Future: Indicate circuit numbers.

2. Multiple Power or Lighting Circuits in the same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color coding for voltage and phase indication of secondary circuit.

3. Multiple control and Communications Circuits in the same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color coding, or cable marking tape.

E. Apply warning, caution, and instruction signs and stencils as follows:

1. Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved, plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.

2. Emergency-Operating Signs: Install engraved laminate signs.

F. Install identification as follows:

1. Use white lettering on black field.

Example: Panel 1H1 208Y/120V, 3-ph, 4-wire fed from Panel MDR-CCT#4

a. Switches and receptacles.

b. Rectifiers.

c. Frequency converters.

d. Telephone switching equipment.

e. Clock/program master equipment.

f. Call system master station.

g. TV/audio monitoring master station.

h. Fire-alarm master station or control panel.

i. Security-monitoring master station or control panel.

2. Circuits: Apply identification labels of engraved plastic laminate on each switch and receptacle indicating panelboard and circuit number supplying receptacle.

G. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

H. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

I. Install identifying devices before installing acoustical ceilings and similar concealment.

J. Verify identity of each item before installing identification products.

K. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

L. Apply identification devices to surfaces that require finish after completing finish work.

M. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

N. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

O. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

P. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

Q. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

R. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.

2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

S. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.

T. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.

U. Self-Adhesive Labels:

1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.

2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.

V. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

W. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.

X. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.

Y. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

Z. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

AA. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.

BB. Underground Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

2. Limit use of underground-line warning tape to direct-buried cables.

3. Install underground-line warning tape for direct-buried cables and cables in raceways.

CC. Metal Tags:

1. Place in a location with high visibility and accessibility.

2. Secure using UV-stabilized, plenum-rated, cable ties.

DD. Nonmetallic Preprinted Tags:

1. Place in a location with high visibility and accessibility.

2. Secure using UV-stabilized, plenum-rated, cable ties.

EE. Write-on Tags:

1. Place in a location with high visibility and accessibility.

2. Secure using UV-stabilized, plenum-rated, cable ties.

FF. Baked-Enamel Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.

GG. Metal-Backed Butyrate Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.

HH. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.

II. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.

2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3-inch-high, black letters on 20-inch centers.

1. Locate identification at changes in direction, at penetrations of walls and floors, and at 10-foot maximum intervals.

D. Accessible Raceways more Than 600 V: Vinyl wraparound labels.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

E. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, more than 20A and 120V to Ground: Identify with self-adhesive raceway labels with vinyl tape applied in bands.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

F. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:

1. "POWER."

2. in straight runs, and at 25-foot maximum intervals in congested areas.

G. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.

H. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes labels with the conductor designation.

I. Conductors to Be Extended in the Future: Attach write-on tags, marker tape, to conductors and list source.

J. Auxiliary Electrical Systems Conductor Identification: Marker tape that is uniform and consistent with system used by manufacturer for factory-installed connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

K. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

L. Concealed Raceways and Duct Banks, More Than 600 V, within Buildings: Apply floor marking tape to the following finished surfaces:

1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.

2. Wall surfaces directly external to raceways concealed within wall.

3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

M. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

N. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.

O. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.

1. Apply to exterior of door, cover, or other access.

2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

a. Power-transfer switches.

b. Controls with external control power connections.

P. Arc Flash Warning Labeling: Self-adhesive labels.

Q. Operating Instruction Signs: Self-adhesive labels.

R. Equipment Identification Labels:

1. Indoor Equipment: Self-adhesive label Laminated acrylic or melamine plastic sign.

2. Outdoor Equipment: Laminated acrylic or melamine sign 4 inches high.

3. Equipment to Be Labeled:

a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, engraved, laminated acrylic or melamine label.

b. Enclosures and electrical cabinets.

c. Access doors and panels for concealed electrical items.

d. Switchboards.

e. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.

f. Enclosed switches.

g. Enclosed circuit breakers.

h. Enclosed controllers.

i. Variable-speed controllers.

j. Push-button stations.

k. Contactors.

l. Remote-controlled switches, dimmer modules, and control devices.

m. Monitoring and control equipment.

END OF SECTION 26 0553

SECTION 26 0573 - ELECTRICAL SYSTEM STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes:

1. Short-circuit study.

2. Overcurrent protective device coordination study.

3. Load-flow and voltage-drop study.

4. Motor-starting study.

5. Arc-flash hazard study.

6. Digital-twin modeling.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

1.2 DEFINITIONS

A. Digital Twin: The digital representation of a real-world entity, concept, or notion, either physical or perceived.

1.3 ACTION SUBMITTALS

A. Product Data: For power system analysis software to be used for studies.

1. Product Certificates: For power system study software applications, include certificate stating compliance with specified requirements, signed by software manufacturer.

B. Power System Study Reports:

1. All studies will be incorporated into the gear submittal for, but not limited to Switchboards and panelboards. Electrical gear will not be reviewed without the incorporation of the coordination and other studies needed to provide a complete gear submittal.

2. Submit reports after approval of system protective devices submittals. Submittals must be in digital form.

3. Submit short-circuit study input data, including completed computer-program input data sheets.

4. Submit coordination study input data, including completed computer-program input data sheets.

    a. Submit load-flow, voltage-drop, and motor-starting data with coordination study.

5. Submit arc-flash study input data, including completed computer-program input data sheets.

6. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

7. Submit revised one-line diagram, reflecting field investigation results and results of short-circuit study.

C. Data files for studies in format compatible with Owner's power system analysis software.

D. Digital-twin models.

1.4 QUALITY ASSURANCE

A. Submittals for power system studies must be signed and sealed by qualified electrical professional engineer responsible for their preparation.

B. Studies must be performed using commercially developed and distributed software designed specifically for power system analysis.

C. Software algorithms must comply with requirements of standards and guides specified in this Section.

D. Manual calculations are unacceptable.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE

A. Standard Features:

1. Power System Analysis:

    a. Power-systems-analysis software applications must have analytical capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 3002 series standards.

b. Computer software application must be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program must report device settings and ratings of overcurrent protective devices and must demonstrate selective coordination by computer-generated, time-current coordination plots.

c. Computer software application must be designed to perform arc-flash analysis or have function, component, or add-on module designed to perform arc-flash analysis.

2. Analysis Standards:

a. Short-Circuit Current Analysis: In accordance with IEEE 3002.3.

b. Device Coordination Analysis: In accordance with IEEE 3004.3 and IEEE 3004.5.

c. Load-Flow Analysis: In accordance with IEEE 3002.2.

d. Motor-Starting Analysis: In accordance with IEEE 3002.7.

e. Harmonic Analysis: In accordance with IEEE 3002.8.

f. Transient Stability Analysis: In accordance with IEEE P3002.9.

g. Arc-Flash Hazard Analysis: In accordance with IEEE 1584.

3. Capable of printing arc-flash hazard warnings for equipment on polyester, weather- and UV-resistant, pressure-sensitive adhesive labels complying with NFPA 70E.

a. Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard study:

1) Equipment designation.

2) Nominal voltage.

3) Protection boundaries.

a) Arc-flash boundary.

b) Restricted approach boundary.

c) Limited approach boundary.

4) Arc-flash PPE category.

5) Required minimum arc rating of PPE in Cal/cm squared.

6) Available incident energy.

7) Working distance.

8) Engineering report number, revision number, and issue date.

B. Other Available Features Required by the Project:

1. Simultaneous faults.

2. Explicit negative sequence.

3. Mutual coupling in zero sequence.

4. Digital-Twin Model: Ability to create a cloud-based, digital-twin model for life-cycle operation and maintenance of the facility's electrical power system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Collect and analyze data for power system studies.

1. Verify completeness of data supplied in one-line diagram on Drawings. Call discrepancies to Architect's attention.

2. For equipment included as Work on the Project, use characteristics submitted under provisions of action submittals and information submittals for the Project.

3. For relocated equipment and equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers in accordance with NFPA 70E.

4. Gather and tabulate required input data to support power system studies. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on Record Document copy of one-line diagram. Comply with recommendations in IEEE 3002 series standards as to amount of detail that is required to be acquired in field. Field data gathering must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:

a. Product data for the Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

b. Electrical power utility impedance at service.

c. Power sources and ties.

d. Short-circuit current at each system bus (three phase and line to ground).

e. Full-load current of loads.

f. Voltage level at each bus.

g. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.

h. For reactors, provide manufacturer and model designation, voltage rating, and impedance.

i. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.

j. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.

k. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.

l. Maximum demands from service meters.

m. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.

n. Motor horsepower and NEMA MG 1 code letter designation.

o. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).

p. Medium-voltage cable sizes, lengths, conductor material, cable construction, metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

q. Derating factors.

3.2 PREPARATION

A. Preparation of Data for Short-Circuit Study:

1. Verify completeness of data supplied on one-line diagram. Call discrepancies to Architect's attention.

2. For equipment included as Work on the Project, use characteristics submitted under provisions of action submittals and information submittals for the Project.

3. Prepare one-line diagram of modeled power system, showing the following:

a. Protective device designations and ampere ratings.

b. Conductor types, sizes, and lengths.

c. Transformer kVA and voltage ratings.

d. Motor and generator designations and kVA ratings.

e. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.

f. Derating factors and environmental conditions.

g. Revisions to electrical equipment required by study.

B. Preparation of Data for Overcurrent Protective Device Coordination Study:

1. Prepare data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, indicating the following:

a. Special load considerations, including starting inrush currents and frequent starting and stopping.

b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.

c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

d. Generator thermal-damage curve.

e. Ratings, types, and settings of utility company's overcurrent protective devices.

f. Special overcurrent protective device settings or types stipulated by utility company.

g. Time-current-characteristic curves of devices indicated to be coordinated.

h. Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

j. Switchgear, switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.

k. Identify series-rated interrupting devices for condition where available fault current is greater than interrupting rating of downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

2. Examine the Project's overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.

3. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

C. Preparation of Data for Arc-Flash Hazard Study:

1. Assemble data from short-circuit study and overcurrent protective device coordination study.

2. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.3 SHORT-CIRCUIT STUDY

A. Base study on device characteristics supplied by device manufacturer.

B. Extent of electrical power system to be studied is indicated on Drawings.

C. Begin short-circuit current analysis at service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 5 kA or less.

2. Exclude equipment supplied by single transformer smaller than 45 kVA.

D. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for the Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

E. Include AC fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase AC systems. Also account for fault-current DC decrement to address asymmetrical requirements of interrupting equipment.

F. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at equipment indicated on one-line diagram.

1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.

G. Include in report identification of protective device applied outside its capacity.

3.4 OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

A. Base study on device characteristics supplied by device manufacturer. When analysis of full range of device is impractical, limiting scope of analysis from 10 to 100 percent of device range is acceptable.

B. Extent of electrical power system to be studied is indicated on Drawings.

C. Begin analysis at service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 5 kA or less.

D. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for the Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

E. Transformer Primary Overcurrent Protective Devices:

1. Device must not operate in response to the following:

a. Inrush current when first energized.

b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.

c. Permissible transformer overloads in accordance with IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings must protect transformers in accordance with IEEE C57.12.00, for fault currents.

F. Motor Protection:

1. Select protection for low-voltage motors in accordance with IEEE 3004.8 and NFPA 70.

2. Select protection for motors served at voltages more than 600 V in accordance with IEEE 620.

G. Conductor Protection: Protect cables against damage from fault currents in accordance with ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 3004.7. Demonstrate that equipment withstands maximum short-circuit current for time equivalent to tripping time of primary relay protection or total clearing time of fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

H. Generator Protection: Select protection in accordance with manufacturer's published instructions and IEEE C37.102.

I. Include AC fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase AC systems. Also account for fault-current DC decrement, to address asymmetrical requirements of interrupting equipment.

J. Include coordination of ground-fault protection devices.

K. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at equipment indicated on one-line diagram.

1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.

L. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.

2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.

3. Application of series-rated devices must be recertified, complying with requirements in NFPA 70.

4. Include in report identification of protective device applied outside its capacity.

3.5 LOAD-FLOW AND VOLTAGE-DROP STUDY

A. Perform load-flow and voltage-drop study to determine steady-state loading profile of system. Analyze power system performance two times as follows:

1. Determine load flow and voltage drop based on full-load currents.

2. Determine load flow and voltage drop based on 80 percent of design capacity of load buses.

3. Prepare load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.6 MOTOR-STARTING STUDY

A. Perform motor-starting study to analyze transient effect of system's voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze effects of motor starting on power system stability.

B. Prepare motor-starting study report, noting light flicker for limits proposed by IEEE 1453, and voltage sags so as not to affect operation of other utilization equipment on system supplying motor.

3.7 ARC-FLASH HAZARD STUDY

A. Comply with NFPA 70E, including Annex D, for arc-flash hazard study.

B. Preparatory Studies: Obtain short-circuit study and overcurrent protective device coordination study results prior to starting arc-flash hazard study.

C. Calculate maximum and minimum contributions of fault-current size.

1. Maximum calculation must assume maximum contribution from utility and must assume motors to be operating under full-load conditions.

2. Calculate arc-flash energy at 85 percent of maximum short-circuit current in accordance with IEEE 1584 recommendations.

3. Calculate arc-flash energy at 38 percent of maximum short-circuit current in accordance with NFPA 70E recommendations.

4. Calculate arc-flash energy with utility contribution at minimum and assume no motor contribution.

D. Calculate arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.

E. Include medium- and low-voltage equipment locations[, except nominal arc-flash hazard warning data may be provided for equipment fed from transformers rated below 240 V(ac), 2000 A, instead of documenting precise calculations].

F. Calculate limited, restricted, and prohibited approach boundaries for each location.

G. Incident energy calculations must consider accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations must account for changing current contributions, as sources are interrupted or decremented with time. Fault contribution from motors and generators must be decremented as follows:

1. Fault contribution from induction motors must not be considered beyond three to five cycles.

2. Fault contribution from synchronous motors and generators must be decayed to match actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 p.u. to 3 p.u. after 10 cycles).

H. Arc-flash energy must generally be reported for maximum of line or load side of circuit breaker. However, arc-flash computation must be performed and reported for both line and load side of circuit breaker as follows:

1. When circuit breaker is in separate enclosure.

2. When line terminals of circuit breaker are separate from work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.8 POWER SYSTEM STUDY REPORTS

A. Preparation of Power System Study Reports: Prepare and submit the following:

1. Short-Circuit Study Report Contents:

a. Executive summary of study findings.

b. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

c. One-line diagram of modeled power system, showing the following:

1) Protective device designations and ampere ratings.

2) Conductor types, sizes, and lengths.

3) Transformer kVA and voltage ratings.

4) Motor and generator designations and kVA ratings.

5) Switchgear, switchboard, motor-control center, and panelboard designations and ratings.

6) Derating factors and environmental conditions.

7) Revisions to electrical equipment required by study.

d. Comments and recommendations for system improvements or revisions in written document, separate from one-line diagram.

e. Short-Circuit Study Input Data:

1) One-line diagram of system being studied.

2) Power sources available.

3) Manufacturer, model, and interrupting rating of protective devices.

4) Conductors.

5) Transformer data.

f. Protective Device Evaluation:

1) Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.

2) Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.

3) For 600 V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

4) For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.

5) Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

g. Short-Circuit Study Output Reports:

1) Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a) Voltage.

b) Calculated fault-current magnitude and angle.

c) Fault-point X/R ratio.

d) Equivalent impedance.

2) Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a) Voltage.

b) Calculated symmetrical fault-current magnitude and angle.

c) Fault-point X/R ratio.

d) Calculated asymmetrical fault currents based on fault-point X/R ratio; based on calculated symmetrical value multiplied by 1.6; and based on calculated symmetrical value multiplied by 2.7.

3) Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a) Voltage.

b) Calculated symmetrical fault-current magnitude and angle.

c) Fault-point X/R ratio.

d) No AC Decrement (NACD) ratio.

e) Equivalent impedance.

f) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.

g) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

2. Overcurrent Protection Device Coordination Study Report Contents:

a. Executive summary of study findings.

b. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

c. One-line diagram of modeled power system, showing the following:

1) Protective device designations and ampere ratings.

2) Conductor types, sizes, and lengths.

3) Transformer kVA and voltage ratings.

4) Motor and generator designations and kVA ratings.

5) Switchgear, switchboard, motor-control center, and panelboard designations.

6) Revisions to electrical equipment required by study.

d. Report recommended settings of protective devices, ready to be applied in field. Use manufacturer's data sheets for recording recommended setting of overcurrent protective devices when available.

1) Phase and Ground Relays:

a) Device tag.

b) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.

c) Recommendations on improved relaying systems, if applicable.

2) Circuit Breakers:

a) Adjustable pickups and time delays (long time, short time, and ground).

b) Adjustable time-current characteristic.

c) Adjustable instantaneous pickup.

d) Recommendations on improved trip systems, if applicable.

3) Fuses: Show current rating, voltage, and class.

e. Time-Current Coordination Curves: 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 switching schemes and for emergency periods where power source is local generation. Show the following information:

1) Device tag and title, one-line diagram with legend identifying portion of system covered.

2) Terminate device characteristic curves at point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

3) Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

4) Plot the following listed characteristic curves, as applicable:

a) Power utility's overcurrent protective device.

b) Medium-voltage equipment overcurrent relays.

c) Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.

d) Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.

e) Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.

f) Cables and conductors damage curves.

g) Ground-fault protective devices.

h) Motor-starting characteristics and motor damage points.

i) Generator short-circuit decrement curve and generator damage point.

j) Largest feeder circuit breaker in each motor-control center and panelboard.

5) Maintain selectivity for tripping currents caused by overloads.

6) Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.

7) Provide adequate time margins between device characteristics such that selective operation is achieved.

8) Comments and recommendations for system improvements.

3. Arc-Flash Hazard Study Report Contents:

a. Executive summary of study findings.

b. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

c. One-line diagram, showing the following:

1) Protective device designations and ampere ratings.

2) Conductor types, sizes, and lengths.

3) Transformer kVA and voltage ratings, including derating factors and environmental conditions.

4) Motor and generator designations and kVA ratings.

5) Switchboard, panelboard designations, and ratings.

d. Short-circuit study output data.

e. Overcurrent protective device coordination study report contents.

f. Arc-Flash Study Output Reports:

1) Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in report:

a) Voltage.

b) Calculated symmetrical fault-current magnitude and angle.

c) Fault-point X/R ratio.

d) No AC Decrement (NACD) ratio.

e) Equivalent impedance.

f) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.

g) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

g. Incident Energy and Flash Protection Boundary Calculations:

1) Arcing fault magnitude.

2) Protective device clearing time.

3) Duration of arc.

4) Arc-flash boundary.

5) Restricted approach boundary.

6) Limited approach boundary.

7) Working distance.

8) Incident energy.

9) Hazard risk category.

10) Recommendations for arc-flash energy reduction.

h. Fault study input data, case descriptions, and fault-current calculations including definition of terms and guide for interpretation of computer printout.

3.9 DIGITAL-TWIN MODELING

A. **Create cloud-based,** digital-twin model of as-constructed facility's electrical power system.

3.10 FIELD ADJUSTMENT FOR DEVICE COORDINATION

A. Adjust relay and protective device settings in accordance with recommended settings provided by coordination study. Field adjustments must be completed by engineering service division of equipment manufacturer under "Startup and Acceptance Testing" contract portion.

B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

C. Testing and adjusting must be by qualified medium-voltage and low-voltage electrical testing and inspecting agency.

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for adjustable overcurrent protective devices.

3.11 WARNING LABELING OF ARC-FLASH HAZARDS

A. Apply one arc-flash label on front cover of each section of equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in study, including each piece of equipment listed below:

1. Switchboards.

2. Panelboards.

3. Low voltage transformers.

4. Safety switches.

5. Control panels.

B. Base arc-flash label data on highest values calculated at each location.

C. Machine print warning labels with no handwritten or field-applied markings.

D. Install arc-flash warning labels under direct supervision and control of qualified electrical professional engineer.

E. Indicate on record Drawings location of equipment where personnel could be exposed to arc-flash hazard during their work.

1. Indicate arc-flash energy.

2. Indicate protection level required.

END OF SECTION

SECTION 260573 - POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes:

1. Short-circuit study.

2. Overcurrent protective device coordination study.

3. Load-flow and voltage-drop study.

4. Motor-starting study.

5. Arc-flash hazard study.

6. Digital-twin modeling.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

1.2 DEFINITIONS

A. Digital Twin: The digital representation of a real-world entity, concept, or notion, either physical or perceived.

1.3 ACTION SUBMITTALS

A. Product Data: For power system analysis software to be used for studies.

1. Product Certificates: For power system study software applications, include certificate stating compliance with specified requirements, signed by software manufacturer.

B. Power System Study Reports:

1. Submit reports after approval of system protective devices submittals. Submittals [**must**] [**may**] be in digital form.

2. Submit short-circuit study input data, including completed computer-program input data sheets.

3. Submit coordination study input data, including completed computer-program input data sheets.

   a. Submit load-flow, voltage-drop, and motor-starting data with coordination study.

4. Submit arc-flash study input data, including completed computer-program input data sheets.

5. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

6. Submit revised one-line diagram, reflecting field investigation results and results of short-circuit study.

C. Data files for studies in format compatible with Owner's power system analysis software.

D. Digital-twin models.

1.4 QUALITY ASSURANCE

A. Submittals for power system studies must be signed and sealed by qualified electrical professional engineer responsible for their preparation.

B. Studies must be performed using commercially developed and distributed software designed specifically for power system analysis.

C. Software algorithms must comply with requirements of standards and guides specified in this Section.

D. Manual calculations are unacceptable.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Standard Features:

1. Power System Analysis:

   a. Power-systems-analysis software applications must have analytical capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 3002 series standards.

   b. Computer software application must be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program must

report device settings and ratings of overcurrent protective devices and must demonstrate selective coordination by computer-generated, time-current coordination plots.

c. Computer software application must be designed to perform arc-flash analysis or have function, component, or add-on module designed to perform arc-flash analysis.

2. Analysis Standards:

a. Short-Circuit Current Analysis: In accordance with IEEE 3002.3.

b. Device Coordination Analysis: In accordance with IEEE 3004.3 and IEEE 3004.5.

c. Load-Flow Analysis: In accordance with IEEE 3002.2.

d. Motor-Starting Analysis: In accordance with IEEE 3002.7.

e. Harmonic Analysis: In accordance with IEEE 3002.8.

f. Transient Stability Analysis: In accordance with IEEE P3002.9.

g. Arc-Flash Hazard Analysis: In accordance with IEEE 1584.

3. Capable of printing arc-flash hazard warnings for equipment on [**polyester**] [**vinyl**], weather- and UV-resistant, pressure-sensitive adhesive labels complying with NFPA 70E.

a. Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard study:

1) Equipment designation.

2) Nominal voltage.

3) Protection boundaries.

a) Arc-flash boundary.

b) Restricted approach boundary.

c) Limited approach boundary.

4) Arc-flash PPE category.

5) Required minimum arc rating of PPE in Cal/cm squared.

6) Available incident energy.

7) Working distance.

8) Engineering report number, revision number, and issue date.

C. Other Available Features Required by the Project:

1. Simultaneous faults.

2. Explicit negative sequence.

3. Mutual coupling in zero sequence.

4. Digital-Twin Model: Ability to create a [**cloud-based,**]digital-twin model for life-cycle operation and maintenance of the facility's electrical power system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Collect and analyze data for power system studies.

1. Verify completeness of data supplied in one-line diagram on Drawings. Call discrepancies to Architect's attention.

2. For equipment included as Work on the Project, use characteristics submitted under provisions of action submittals and information submittals for the Project.

3. For [**relocated equipment and**]equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers in accordance with NFPA 70E.

4. Gather and tabulate required input data to support power system studies. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on Record Document copy of one-line diagram. Comply with recommendations in IEEE 3002 series standards as to amount of detail that is required to be acquired in field. Field data gathering must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:

a. Product data for the Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

b. Electrical power utility impedance at service.

c. Power sources and ties.

d. Short-circuit current at each system bus (three phase and line to ground).

e. Full-load current of loads.

f. Voltage level at each bus.

g. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.

h. For reactors, provide manufacturer and model designation, voltage rating, and impedance.

i. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.

j. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.

k. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.

l. Maximum demands from service meters.

m. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.

n. Motor horsepower and NEMA MG 1 code letter designation.

o. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).

p. Medium-voltage cable sizes, lengths, conductor material, cable construction, metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

q. Derating factors.

3.2 PREPARATION

A. Preparation of Data for Short-Circuit Study:

1. Verify completeness of data supplied on one-line diagram. Call discrepancies to Architect's attention.

2. For equipment included as Work on the Project, use characteristics submitted under provisions of action submittals and information submittals for the Project.

3. Prepare one-line diagram of modeled power system, showing the following:

a. Protective device designations and ampere ratings.

b. Conductor types, sizes, and lengths.

c. Transformer kVA and voltage ratings.

d. Motor and generator designations and kVA ratings.

e. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.

f. Derating factors and environmental conditions.

g. Revisions to electrical equipment required by study.

B. Preparation of Data for Overcurrent Protective Device Coordination Study:

1. Prepare data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, indicating the following:

a. Special load considerations, including starting inrush currents and frequent starting and stopping.

b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.

c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

d. Generator thermal-damage curve.

e. Ratings, types, and settings of utility company's overcurrent protective devices.

f. Special overcurrent protective device settings or types stipulated by utility company.

g. Time-current-characteristic curves of devices indicated to be coordinated.

h. Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

j. Switchgear, switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.

k. Identify series-rated interrupting devices for condition where available fault current is greater than interrupting rating of downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

2. Examine the Project's overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.

3. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

C. Preparation of Data for Arc-Flash Hazard Study:

1. Assemble data from short-circuit study and overcurrent protective device coordination study.

2. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.3 SHORT-CIRCUIT STUDY

A. Base study on device characteristics supplied by device manufacturer.

B. Extent of electrical power system to be studied is indicated on Drawings.

C. Begin short-circuit current analysis at service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 5 kA or less.

2. Exclude equipment supplied by single transformer smaller than 75 kVA.

3. <Insert description>.

D. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for the Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

E. Include AC fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase AC systems. Also account for fault-current DC decrement to address asymmetrical requirements of interrupting equipment.

F. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at equipment indicated on one-line diagram.

1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.

G. Include in report identification of protective device applied outside its capacity.

3.4 OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

A. Base study on device characteristics supplied by device manufacturer.[**When analysis of full range of device is impractical, limiting scope of analysis from 10 to 100 percent of device range is acceptable.**]

B. Extent of electrical power system to be studied is indicated on Drawings.

C. Begin analysis at service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 5 kA or less.

2. <Insert description>.

D. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for the Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

E. Transformer Primary Overcurrent Protective Devices:

1. Device must not operate in response to the following:

a. Inrush current when first energized.

b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.

c. Permissible transformer overloads in accordance with IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings must protect transformers in accordance with IEEE C57.12.00, for fault currents.

F. Motor Protection:

1. Select protection for low-voltage motors in accordance with IEEE 3004.8 and NFPA 70.

2. Select protection for motors served at voltages more than 600 V in accordance with IEEE 620.

G. Conductor Protection: Protect cables against damage from fault currents in accordance with ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 3004.7. Demonstrate that equipment withstands maximum short-circuit current for time equivalent to tripping time of primary relay protection or total clearing time of fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

H. Generator Protection: Select protection in accordance with manufacturer's published instructions and IEEE C37.102.

I. Include AC fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase AC systems. Also account for fault-current DC decrement, to address asymmetrical requirements of interrupting equipment.

J. Include coordination of ground-fault protection devices.

K. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at equipment indicated on one-line diagram.

1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.

L. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.

2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.

3. Application of series-rated devices must be recertified, complying with requirements in NFPA 70.

4. Include in report identification of protective device applied outside its capacity.

3.5 LOAD-FLOW AND VOLTAGE-DROP STUDY

A. Perform load-flow and voltage-drop study to determine steady-state loading profile of system. Analyze power system performance two times as follows:

1. Determine load flow and voltage drop based on full-load currents.

2. Determine load flow and voltage drop based on 80 percent of design capacity of load buses.

3. Prepare load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.6 MOTOR-STARTING STUDY

A. Perform motor-starting study to analyze transient effect of system's voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze effects of motor starting on power system stability.

B. Prepare motor-starting study report, noting light flicker for limits proposed by IEEE 1453, and <**Insert applicable standards**>, and voltage sags so as not to affect operation of other utilization equipment on system supplying motor.

3.7 ARC-FLASH HAZARD STUDY

A. Comply with NFPA 70E, including Annex D, for arc-flash hazard study.

B. Preparatory Studies: Obtain short-circuit study and overcurrent protective device coordination study results prior to starting arc-flash hazard study.

C. Calculate maximum and minimum contributions of fault-current size.

1. Maximum calculation must assume maximum contribution from utility and must assume motors to be operating under full-load conditions.

2. Calculate arc-flash energy at 85 percent of maximum short-circuit current in accordance with IEEE 1584 recommendations.

3. Calculate arc-flash energy at 38 percent of maximum short-circuit current in accordance with NFPA 70E recommendations.

4. Calculate arc-flash energy with utility contribution at minimum and assume no motor contribution.

D. Calculate arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.

E. Include medium- and low-voltage equipment locations[**, except nominal arc-flash hazard warning data may be provided for equipment fed from transformers rated below 240 V(ac), 2000 A, instead of documenting precise calculations**].

F. Calculate limited, restricted, and prohibited approach boundaries for each location.

G. Incident energy calculations must consider accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations must account for changing current contributions, as sources are interrupted or decremented with time. Fault contribution from motors and generators must be decremented as follows:

1. Fault contribution from induction motors must not be considered beyond three to five cycles.

2. Fault contribution from synchronous motors and generators must be decayed to match actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 p.u. to 3 p.u. after 10 cycles).

H. Arc-flash energy must generally be reported for maximum of line or load side of circuit breaker. However, arc-flash computation must be performed and reported for both line and load side of circuit breaker as follows:

1. When circuit breaker is in separate enclosure.

2. When line terminals of circuit breaker are separate from work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.8 POWER SYSTEM STUDY REPORTS

A. Preparation of Power System Study Reports: Prepare and submit the following:

1. Short-Circuit Study Report Contents:

a. Executive summary of study findings.

b. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

c. One-line diagram of modeled power system, showing the following:

1) Protective device designations and ampere ratings.

2) Conductor types, sizes, and lengths.

3) Transformer kVA and voltage ratings.

4) Motor and generator designations and kVA ratings.

5) Switchgear, switchboard, motor-control center, and panelboard designations and ratings.

6) Derating factors and environmental conditions.

7) Revisions to electrical equipment required by study.

d. Comments and recommendations for system improvements or revisions in written document, separate from one-line diagram.

e. Short-Circuit Study Input Data:

1) One-line diagram of system being studied.

2) Power sources available.

3) Manufacturer, model, and interrupting rating of protective devices.

4) Conductors.

5) Transformer data.

f. Protective Device Evaluation:

1) Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.

2) Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.

3) For 600 V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

4) For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.

5) Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

g. Short-Circuit Study Output Reports:

1) Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a) Voltage.

b) Calculated fault-current magnitude and angle.

c) Fault-point X/R ratio.

d) Equivalent impedance.

2) Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a) Voltage.

b) Calculated symmetrical fault-current magnitude and angle.

c) Fault-point X/R ratio.

d) Calculated asymmetrical fault currents based on fault-point X/R ratio; based on calculated symmetrical value multiplied by 1.6; and based on calculated symmetrical value multiplied by 2.7.

3) Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a) Voltage.

b) Calculated symmetrical fault-current magnitude and angle.

c) Fault-point X/R ratio.

d) No AC Decrement (NACD) ratio.

e) Equivalent impedance.

f) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.

g) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

2. Overcurrent Protection Device Coordination Study Report Contents:

a. Executive summary of study findings.

b. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

c. One-line diagram of modeled power system, showing the following:

1) Protective device designations and ampere ratings.

2) Conductor types, sizes, and lengths.

3) Transformer kVA and voltage ratings.

4) Motor and generator designations and kVA ratings.

5) Switchgear, switchboard, motor-control center, and panelboard designations.

6) Revisions to electrical equipment required by study.

d. Report recommended settings of protective devices, ready to be applied in field. Use manufacturer's data sheets for recording recommended setting of overcurrent protective devices when available.

1) Phase and Ground Relays:

a) Device tag.

b) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.

c) Recommendations on improved relaying systems, if applicable.

2) Circuit Breakers:

a) Adjustable pickups and time delays (long time, short time, and ground).

b) Adjustable time-current characteristic.

c) Adjustable instantaneous pickup.

d) Recommendations on improved trip systems, if applicable.

3) Fuses: Show current rating, voltage, and class.

e. Time-Current Coordination Curves: 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 switching schemes and for emergency periods where power source is local generation. Show the following information:

1) Device tag and title, one-line diagram with legend identifying portion of system covered.

2) Terminate device characteristic curves at point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

3) Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

4) Plot the following listed characteristic curves, as applicable:

a) Power utility's overcurrent protective device.

b) Medium-voltage equipment overcurrent relays.

c) Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.

d) Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.

e) Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.

f) Cables and conductors damage curves.

g) Ground-fault protective devices.

h) Motor-starting characteristics and motor damage points.

i) Generator short-circuit decrement curve and generator damage point.

j) Largest feeder circuit breaker in each motor-control center and panelboard.

5) Maintain selectivity for tripping currents caused by overloads.

6) Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.

7) Provide adequate time margins between device characteristics such that selective operation is achieved.

8) Comments and recommendations for system improvements.

3. Arc-Flash Hazard Study Report Contents:

a. Executive summary of study findings.

b. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

c. One-line diagram, showing the following:

1) Protective device designations and ampere ratings.

2) Conductor types, sizes, and lengths.

3) Transformer kVA and voltage ratings, including derating factors and environmental conditions.

4) Motor and generator designations and kVA ratings.

5) Switchgear, switchboard, motor-control center, panelboard designations, and ratings.

d. Short-circuit study output data.

e. Overcurrent protective device coordination study report contents.

f. Arc-Flash Study Output Reports:

1) Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in report:

a) Voltage.

b) Calculated symmetrical fault-current magnitude and angle.

c) Fault-point X/R ratio.

d) No AC Decrement (NACD) ratio.

e) Equivalent impedance.

f) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.

g) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

g. Incident Energy and Flash Protection Boundary Calculations:

1) Arcing fault magnitude.

2) Protective device clearing time.

3) Duration of arc.

4) Arc-flash boundary.

5) Restricted approach boundary.

6) Limited approach boundary.

7) Working distance.

8) Incident energy.

9) Hazard risk category.

10) Recommendations for arc-flash energy reduction.

h. Fault study input data, case descriptions, and fault-current calculations including definition of terms and guide for interpretation of computer printout.

3.9 DIGITAL-TWIN MODELING

A. [**Create**] [**Update existing**] [**cloud-based,**]digital-twin model of as-constructed facility's electrical power system.

1. <Insert Owner's requirements>

3.10 FIELD ADJUSTMENT FOR DEVICE COORDINATION

A. Adjust relay and protective device settings in accordance with recommended settings provided by coordination study. Field adjustments must be completed by engineering service division of equipment manufacturer under "Startup and Acceptance Testing" contract portion.

B. Make minor modifications to equipment as required to accomplish compliance with [**short-circuit and**]protective device coordination studies.

C. Testing and adjusting must be by qualified [**medium-voltage and**]low-voltage electrical testing and inspecting agency.

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for adjustable overcurrent protective devices.

3.11 WARNING LABELING OF ARC-FLASH HAZARDS

A. Apply [**one**]arc-flash label on front cover [**of each section of equipment**] [**and on side or rear covers with accessible live parts and hinged doors or removable plates**] for each equipment included in study, including each piece of equipment listed below:

1. Medium-voltage switchgear.

2. Medium-voltage switches.

3. Medium voltage transformers.

4. Low-voltage switchgear.

5. Switchboards.

6. Panelboards.

7. Motor-control centers.

8. Low voltage transformers.

9. Safety switches.

10. Control panels.

11. <Insert equipment>.

B. Base arc-flash label data on highest values calculated at each location.

C. Machine print warning labels with no handwritten or field-applied markings.

D. Install arc-flash warning labels under direct supervision and control of qualified electrical professional engineer.

E. Indicate on record Drawings location of equipment where personnel could be exposed to arc-flash hazard during their work.

1. Indicate arc-flash energy.

2. Indicate protection level required.

END OF SECTION 260573

SECTION 26 0880 – ELECTRICAL ACCEPTANCE TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Refer to individual specification sections indicated below for tests to be performed and other requirements.

1.2 QUALITY ASSURANCE

A. Engage and pay for the services of a recognized independent Electrical Testing Agency for the purpose of performing the independent inspections, tests, adjustments and settings as specified herein and in other sections.

B. The Electrical Testing Agency shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.

C. The Electrical Testing Agency shall submit appropriate documentation to demonstrate that it satisfactorily complies with the following. An organization having a "Full Membership" classification issued by the InterNational Electrical Testing Association.

1. The Electrical Testing Agency shall be an independent, third party, testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing organization.

2. The Electrical Testing Agency shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

D. The Electrical Testing Agency shall utilize technicians who are regularly employed for testing services.

E. Technicians performing these electrical tests and inspections shall be trained and experienced concerning the apparatus and systems being evaluated. These individuals shall be capable of conducting the tests in a safe manner and with complete knowledge of the hazards involved. They must evaluate the test data and make an informed judgment on the continued serviceability or non-serviceability of the specific equipment. Technicians shall be certified in accordance with ANSI/NETA ETT–2000, Standard for Certification of Electrical Testing Technicians. Each on-site crew leader shall hold a current certification, Level III or higher, in electrical testing.

1.3 PERFORMANCE CRITERIA

A. Perform acceptance testing, inspection, and calibration to assure that installed electrical systems and equipment, either Owner or Subcontractor supplied are:

1. Installed in accordance with design Specifications and manufacturer's instructions,

2. Ready to be energized,

3. Operational and within industry and manufacturer's tolerances.

B. The following is a list of equipment and systems to be inspected, tested and calibrated by the Electrical Testing Agency. Refer to these specification sections for tests required.

Section Number	Section Title Equipment / System
26 2413	**SWITCHBOARDS**
26 2416	**PANELBOARDS**
26 2213	**TRANSFOMRERS**
26 2816	**ENCLOSED SWITCHES AND CIRCUIT BREAKERS**

1.4 REGULATORY REQUIREMENTS

A. Make Inspections and tests in accordance with the applicable codes and standards of the following agencies except as provided otherwise herein:

1. InterNational Electrical Testing Association – NETA ATS latest Edition: Acceptance Testing Specifications.

2. ANSI/NETA ETT – 2000, Standard for the Certification of Electrical Testing Technicians

3. National Fire Protection Association – NFPA.
   a. ANSI/NFPA 70: National Electrical Code.
   b. ANSI/NFP A 70B: Recommended Practice for Electrical Equipment Maintenance.
   c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces.
   d. NFPA 99 & 101.

B. Use the following references:

1. Project design Specifications.

2. Project OVERCURRENT PROTECTIVE DEVICE STUDY – refer to Section 26 0573.

3. Manufacturer's instruction manuals applicable to each particular apparatus.

4. Project list of equipment to be inspected and tested.

1.5 GENERAL REQUIREMENTS

A. Safety and Precautions

1. Safety practices shall include, but are not limited to, the following requirements:
   a. Occupational Safety and Health Act.
   b. Accident Prevention Manual for Industrial Operations, National Safety Council.
   c. Applicable state and local safety operating procedures.
   d. Owner's safety practices.
   e. ANSI/NFPA 70E, Electrical Safety Requirements for Employee Workplaces.

2. All tests shall be performed with apparatus de-energized except where otherwise specifically required.

3. The Electrical Testing Agency shall have a designated safety representative on the project to supervise operations with respect to safety.

B. Suitability of Test Equipment

1. All test equipment shall be in good mechanical and electrical condition.

2. Split-core current transformers and clamp-on or tong-type ammeters require consideration of the following in regard to accuracy:
   a. Position of the conductor within the core
   b. Clean, tight fit of the core pole faces
   c. Presence of external magnetic fields
   d. Accuracy of the current transformer ratio in addition to the accuracy of the secondary meter.

3. Selection of metering equipment shall be based on a knowledge of the waveform of the variable being measured. Digital multimeters may be average or RMS sensing and may include or exclude the dc component. When the variable contains harmonics or dc offset and, in general, any deviation from a pure sine wave, average sensing, RMS scaled meters may be misleading.

4. Field test metering used to check power system meter calibration must have accuracy higher than that of the instrument being checked.

5. Accuracy of metering in test equipment shall be appropriate for the test being performed but not in excess of two percent of the scale used.

6. Waveshape and frequency of test equipment output waveforms shall be appropriate for the test and tested equipment.

C. Test Instrument Calibration

1. The Electrical Testing Agency shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

2. The accuracy shall be directly traceable to the National Institute of Standards and Technology (NIST).

3. Instruments shall be calibrated in accordance with the following frequency schedule:
   a. Field instruments: Analog, 6 months maximum; Digital, 12 months maximum
   b. Laboratory instruments: 12 months
   c. Leased specialty equipment: 12 months where accuracy is guaranteed by lessor.

4. Dated calibration labels shall be visible on all test equipment.

5. Records, which show date and results of instruments calibrated or tested, shall be kept up-to-date.

6. Up-to-date instrument calibration instructions and procedures shall be maintained for each test instrument.

7. Calibrating standard shall be of higher accuracy than that of the instrument tested.

D. Test Report

1. The test report shall include the following:
   a. Summary of project.
   b. Description of equipment tested.
   c. Description of test.
   d. Test data.
   e. Analysis and recommendations.

2. Test data records shall include the following minimum requirements:
   a. Identification of the testing organization.
   b. Equipment identification.
   c. Humidity, temperature, and other atmospheric conditions that may affect the results of the tests/calibrations.
   d. Date of inspections, tests, maintenance, and/or calibrations.
   e. Identification of the testing technician.
   f. Indication of inspections, tests, maintenance, and/or calibrations to be performed and recorded.
   g. Indication of expected results when calibrations are to be performed.
   h. Indication of “as-found” and “as-left” results.
   i. Sufficient spaces to allow all results and comments to be indicated.

3. The Electrical Testing Agency shall furnish a copy or copies of the complete report to the owner and Commissioning Authority as required in the acceptance contract.

1.6 SUBMITTALS

A. Qualifications of the Electrical Testing Agency shall be submitted to the COMMISSIONING AUTHORITY for review with the electrical equipment submittals in accordance with Section 26 05 00, "COMMON WORK RESULTS FOR ELECTRICAL, Submittals."

PART 2 - PRODUCTS

1. Not Applicable

PART 3 - EXECUTION

3.1 GENERAL

A. Set all adjustable circuit breaker trip settings in accordance with the trip setting report from the ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY.

B. Test, inspect and calibrate the following electrical equipment in strict accordance with applicable sections of NETA ATS-2003.

1. Electrical equipment shown on the electrical Drawings.

2. Electrical equipment specified in all Division 26 Specifications for the Site.

3. Electrical equipment furnished under other Divisions of the Specifications and connected under Division 26.

C. Perform acceptance tests and inspections prior to energizing equipment, unless where energization is required to perform specified tests.

D. Final acceptance will not occur before completion of the electrical acceptance tests, inspections and calibrations specified in this Section.

3.2 FIELD QUALITY CONTROL

A. Standards: Comply with applicable standards of the InterNational Electrical Testing Association (NETA), including standard ATS.

B. Acceptance Testing: After installing equipment and BEFORE electrical circuitry has been energized. Demonstrate product capability and compliance with requirements.

3.3 DIVISION OF RESPONSIBILITY

A. The Electrical Testing Agency shall provide all material, equipment, labor and technical supervision to perform such tests and inspections as specified herein.

B. The Electrical Testing Agency is responsible for programming all protective and alarming devices with the proper settings provided by the ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY. Settings shall not be changed or applied to any device without written authorization from the Owner.

C. The Electrical Testing Agency shall notify the Commissioning Authority and Owner immediately upon the discovery of any defective equipment or incorrect system design or installation.

D. The Electrical Testing Agency shall provide an experienced person on-site during energizing, with appropriate test equipment to provide assistance in the event of a malfunction during the system start-up process.

3.4 ACCEPTANCE TESTING PROCEDURES

A. Testing and acceptance procedures for the equipment and systems listed in Part 1 shall be as described in the individual equipment specification sections listed above.

END OF SECTION 26 0880

SECTION 26 0923 – DIGITAL OCCUPANCY AND DAYLIGHT MANAGEMENT CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Digital Occupancy and Daylighting Sensor Control

2. Emergency Lighting Control (if applicable)

B. Related Section

1. Section 26 2416 – Panelboards.

2. Section 26 2726 – Wiring Devices.

3. Section 26 5119 – LED Interior Lighting.

4. Section 26 0500 – Common Work Results

C. Control Intent – Control Intent includes, but is not limited to:

1. Defaults and initial calibration settings for such items as time delay, sensitivity, fade rates, etc.

2. Initial sensor and switching zones

3. Initial time switch settings

4. Task lighting and receptacle controls

5. Emergency Lighting control (if applicable)

1.2 REFERENCES

A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) (www.ansi.org and www.ieee.org)

B. Canadian Standards Association (CSA) (www.csa.ca).

C. International Electrotechnical Commission (www.iec.ch)

D. International Organization for Standardization (ISO) (www.iso.ch):

E. National Electrical Manufacturers Association (NEMA) (www.nema.org)

F. WD1 (R2005) - General Color Requirements for Wiring Devices.

G. Underwriters Laboratories, Inc. (UL) (www.ul.com):

1. 916 – Energy Management Equipment.

2. 924 – Emergency Lighting

H. International Building (IBC) Current Issue

1.3 SYSTEM DESCRIPTION & OPERATION

A. The Lighting Control and Automation system as defined under this section covers the following equipment:

1. Digital Room Controllers – Self configuring, digitally addressable one, two or three relays controllers with 0-10v control for ballasts (if applicable) and single relay application specific plug load controllers.

2. Digital Occupancy Sensors – Self configuring, digitally addressable and calibrated occupancy sensors with LCD screens and two way active Infra-Red (IR) configurations.

3. Digital Switches – Self configuring, digitally addressable push button switches, dimmers, and scene switches with two way active Infra-Red (IR) communications.

4. Analog and digital closed loop daylighting sensors - self-calibrating daylighting sensors that provide closed loop control to Room Controllers. Sensors and Room Controllers can provide single or multi-zone, on/off or dimming control for daylight harvesting.

5. Hand held remotes for room configuration – provides two way infrared communications to digital devices and allows complete configuration and reconfiguration of the device / room from 30 feet away. Unit to have Organic LED display, simple pushbutton interface, and allow send / receive / store of all room variables.

6. Hand held remotes for personal control – One, two, or four (scene) button remotes provide Infrared communications to a room. Remote controls will support ON/OFF, scene control and may be configured in the field to provide specific occupant requirements without special tools.

7. Digital Lighting Management (DLM) local network – Free topology, plug in wiring system (Cat 5e) for power and data to room devices.

8. Native BACnet Module (if applicable) – Provide MS/TP communications for Room to Room, or Room to Server communications.

9. Emergency Lighting Control Unit (ELCU)- allows any standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building

1.4 LIGHTING CONTROL APPLICATIONS

A. Unless relevant provisions of the applicable local Energy Codes are more stringent, provide a minimum application of lighting controls as follows:

1. Space Control Requirements – Provide occupancy/vacancy sensors with manual-on functionality in all spaces except toilet rooms, storerooms, library stacks, or other applications where hands-free operation is desirable and automatic-on occupancy sensors are more appropriate. Provide manual ON occupancy/vacancy sensors for any enclosed office, conference room, meeting room, open plan system and training room. For spaces with multiple occupants or where line-of-sight may be obscured, provide ceiling- or corner-mounted sensors with manual-on switches.

2. Bi-Level Lighting – Provide multi –level switched dimming controls in all spaces except toilet rooms, storerooms, library stacks, or applications where variable dimming is used.

3. Task Lighting / Plug Loads – Provide automatic shut off of non essential plug loads and task lighting in all spaces except toilet rooms and storerooms. Provide automatic ON of plug loads whenever spaces are occupied. For spaces with multiple occupants a single shut off consistent with the overhead lighting may be used for the area.

4. Daylighted Areas. All luminaries within 15’ of windows or within 7’ of skylights (the daylighted zone) shall be separately controlled from luminaires outside of daylighted zones. Luminaires closest to the daylight aperture shall be separately controlled from luminaires farther from the daylight aperture, within the daylight zone.

5. Daytime set points for total illumination (combined daylight and electric light) level that initiate dimming shall be programmed to be not less than 125% of the nighttime maintained designed illumination levels.

6. Multiple-leveled switched daylight harvesting controls may be utilized for areas marked on drawings.

7. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylight system may be designed to turn off ambient lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.

B. Additional controls.

1. Provide occupancy/vacancy sensors for any enclosed office, conference room, meeting room, and training room. For spaces with multiple occupants or where line-of-sight may be obscured, provide ceiling- or corner-mounted with manual-on switches.

2. Conference, meeting, training, auditoriums, and multipurpose rooms shall have controls that allow for independent control of each local control zone. Rooms larger than 300 square feet shall instead have at least four (4) pre-set lighting scenes unless otherwise specified. Occupancy / vacancy sensors shall be provided to extinguish all lighting in the space.

1.5 SUBMITTALS

A. Submittals Package: Submit the shop drawings, and the product data specified below at the same time as a package.

B. Each lighting Sequence of operation will be grouped individually and will encompass all required wiring, devices, power booth line voltage and low voltage wiring.

C. Shop Drawings (For Lighting Sequence or operation):

1. Composite wiring and/or schematic diagram of each control circuit as proposed to be installed (standard diagrams will not be accepted).

2. Scale drawing for each area showing exact location of each sensor, switching module, and on-off-auto switch.

D. Product Data: Catalog sheets, specifications and installation instructions.

E. Include data for each device which:

1. Indicates where sensor is proposed to be installed.

2. Prove that the sensor is suitable for the proposed application.

1.6 QUALITY ASSURANCE

A. Manufacturer: Minimum 10 years experience in manufacture of lighting controls.

1.7 PROJECT CONDITIONS

A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:

1. Ambient temperature: 0° to 40° C (32° to 104° F).

2. Relative humidity: Maximum 90 percent, non-condensing.

1.8 WARRANTY

A. Provide a five year complete manufacturer’s warranty on all products to be free of manufacturers’ defects.

1.9 MAINTENANCE

A. Spare Parts:

1. Provide 5 of each product to be used for maintenance.

2. Provide two of each cable length used in the project. Identify all cable lengths in the shop drawings for each lighting sequence of operation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer:

1. Basis of design product: Watt Stopper Digital Lighting Management (DLM) or subject to compliance and prior approval with specified requirements of this section, one of the following:
   a. Watt Stopper Digital Lighting Management (DLM)

B. Substitutions:

1. All proposed prior substitutions (clearly delineated as such) must be submitted in writing for approval by the design professional a minimum of 20 working days prior to the bid date and must be made available to all bidders. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.

2. By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring. The contractor shall provide complete engineered shop drawings (including power wiring) with deviations for the original design highlighted in an alternate color to the engineer for review and approval prior to rough-in.

2.2 SINGLE / DUAL RELAY WALL SWITCH VACANCY SENSORS

A. Type PW: Manual ON, Automatic OFF Wall switch type passive infrared occupancy sensor with built-in override control (off-auto). Furnish the Company's model which suits the electrical system parameters, and accommodates the square footage coverage and wattage requirement for each area (and type of lighting) controlled; Watt Stopper PW-100, PW-200.

B. Type UW: Manual ON, Automatic OFF Wall switch type ultrasonic occupancy sensor with built-in override control (off-auto). Furnish the Company's model which suits the electrical system parameters, and accommodates the square footage coverage and wattage requirement for each area (and type of lighting) controlled; Watt Stopper UW-100, UW-200.

C. Type DW: Manual ON, Automatic OFF Wall switch type dual technology, passive Infrared and ultrasonic occupancy sensor with built-in override control (off-auto). Furnish the Company's model which suits the electrical system parameters, and accommodates the square footage coverage and wattage requirement for each area (and type of lighting) controlled; Watt Stopper DW-100, DW-200.

2.3 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR SYSTEM

A. Wall or ceiling mounted (to suit installation) passive infrared, ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor. Furnish the Company's system which accommodates the square footage coverage requirements for each area controlled, utilizing Room Controller modules and accessories which suits the lighting and electrical system parameters.

B. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:

1. Digital calibration and LCD entry for the following variables:
   a. Sensitivity,
   b. Time Delay
   c. PIR, Ultrasonic or Dual Technology activation
   d. Re-strike times.
   e. Walk-through mode

2. Two RJ-45 digital connections for DLM local network.

3. Two-way infrared communications port to allow remote programming through hand held commissioning tool.

4. Self contained push buttons for programming and control of room devices.

5. Device Status LED's including:
   a. Network Status LED to indicate data transmission
   b. Power LED to indicate the device has power
   c. LED for each sensor technology to indicate detected motion.

C. Units will provide for digital calibration and commissioning and will not have any dip switches or potentiometers for field settings

D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required

E. Watt Stopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC

2.4 DIGITAL WALL SWITCHES

A. Low voltage (RJ-45) momentary push button switches in 1,2,3,4 and 8 button configuration, decorator opening. Wall switches will include the following features:

1. Two way infrared communications port for use with personal and configuration remote controls.

2. LED's for status, programming, and troubleshooting including:
   a. One pilot LED for each button.
   b. One locator LED per switch.

3. Engraveable buttons

4. Dimming switches shall include seven LED's to indicate load levels.

5. Scene switches shall include pilot indication of scene selection.

6. Device Status LED's including:
   a. Network Status LED to indicate data transmission
   b. Power LED to indicate the device has power

B. Switches shall have two RJ-45 ports to allow connection to any other digital room device.

C. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required to achieve multi-way switching

D. Watt Stopper product numbers: LMSW-101 / LMSW-102 / LMSW-103 / LMSW-104 / LMSW-108.

2.5 ROOM CONTROLLERS

A. Room Controllers automatically bind the room loads to the connected devices in the space without any tools or configuration requirements. Room Controllers shall be provided to match the room lighting load and control requirements and sequences. The controllers will be simple to install and will not have screw type connections, dip switches, potentiometers or require special mounting or configuration. The control units will include the following features:

1. Automatic room configuration to the most energy efficient sequence of operation based upon the devices in the room.

2. One or two relay configuration

3. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an Off-the-Shelf unit without requiring any configuration or setup.

4. Device Status LED's including:
   a. Network Status LED to indicate data transmission.
   b. Power LED to indicate the device has power.
   c. Load status.

5. Quick installation features including:
   a. Standard junction box mounting.
   b. Quick low voltage connections using standard RJ-45 patch cables.
   c. Manual override and pilot indication for each load.
   d. Universal voltage (120 – 277 VAC).
   e. Zero cross circuitry.
   f. Low power consumption, 150 ma switched power supply for sensors and switches.
   g. Three RJ-45 DLM local network ports.
   h. Watt Stopper product numbers: LMRC-101 / LMRC-102.
   i. Enhanced Room Controllers shall include all the features of the Room Controller plus the following enhancements:

j. One, two or three relay configuration.
k. 250 ma switched power supply.
l. Four RJ-45 DLM local network ports.
m. One zero to 10 volt analog output per relay for control of dimmable ballasts.
n. Optional BACnet MS/TP communications port.
o. Current monitoring.
p. Watt Stopper product numbers: LMRC-301 / LMRC302 / LMRC303.
q. Plug Load Room Controllers provide dedicated control of plug loads within the space. The controllers plug into the DLM local network using the RJ-45 free topology network. The room controllers include the following features.
r. One relay configuration only.
s. Automatic ON/OFF configuration based upon room occupancy.
t. Default 30 minute (adjustable) additional time delay from lighting shut off to allow for electronic component use after an area is vacant.
u. Watt Stopper product number: LMPL-101.

2.6 DIGITAL PHOTOSENSORS

A. Provide automatic daylight harvesting capabilities to the Room Controllers. The photo sensor / room controller configuration automatically configures the daylighting set points for ON/OFF or Dimming control. Using the automatic configuration replacing a photo sensor or room controller can be done without any special tools, programming or configuration. Photosensors include the following features:

1. The digital photosensor shall utilize an internal photodiode that measures light in a 100 degree angle cutting the unwanted light from bright sources outside of this cone

2. The digital photosensor shall be capable of turning lighting on and off or Raise / Lower depending on the binding to the Room Controller. Sensor range shall be from 1 - 1400fc.

3. For ON/OFF daylight harvesting the controller provides a “hold on while occupied” feature that prohibits high levels from turning OFF the controlled lights as long as the space remains occupied.

4. The sensor has a threaded nipple that mounts on a ceiling tile and for more challenging applications such as a side wall or hard rock ceiling the nipple pops off and the unit can be screwed down

B. Watt Stopper Product Numbers: LMLS-105, LMLS-305.

2.7 ROOM NETWORK

A. The DLM local network is a free topology lighting control network and protocol designed to control a small area of a building. Digital room devices connect to the network using RJ-45 patch cords which provide both data and power to the sensors and switches. Features of the DLM local network include

1. Automatic configuration and binding of sensors, switches and lighting loads to the most energy efficient sequence of operation based upon the device attached.

2. Simple replacement of any device in the network with a standard off the shelf unit without requiring commissioning, configuration or setup.

3. Push and Learn configuration that can change the automatic binding process and load parameters by using only the digital devices in the room.

4. Two way infrared communications that allow load parameters, sensor configuration and binding operations to be configured through a hand held configuration tool up to 30 feet from any device

B. Support for the following devices within a room:

1. 64 loads within the room

2. 64 switches

3. 6 occupancy sensors

4. Maximum of 800 milliamps of power for sensors, switches and auxiliary devices.

2.8 EMERGENCY LIGHTING

A. Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is resotred. Features include

1. 120 - 277 volts, 50/60 Hz, 20 amp ballast rating

2. Push to test button

3. Auxiliary contract for test / Fire Alarm system

PART 3 - EXECUTION

3.1 INSTALLATION

A. When using wire other than RJ-45 connections provide detailed point to point wiring diagrams for every termination. Provide wire specifications and wire colors to simplify contactor termination requirements

B. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated.

C. Calibrate all sensor time delays and sensitivity to guarantee proper coverage of occupants and energy savings.

1. Adjust time delay so that controlled area remains lighted for 5 minutes after occupant leaves area.

D. Provide written or computer generated documentation on the commissioning of the system including room by room description including:

1. Sensor parameters, time delays, sensitivities, daylighting set points.

2. Sequence of operation, manual ON, Auto OFF, etc.

3. Load Parameters - blink warning, etc.

E. Re-commissioning – After 30 days from occupancy re-calibrate all sensors time delays and sensitivities to meet the Owner's Project Requirements. Provide a detailed report to the Architect / Owner of re-commissioning activity.

F. Spare Parts – Provide to Owner five (5) spare units of each device and cable used in this system

END OF SECTION 23 0923

SECTION 26 0923 – LIGHTING AND CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of lighting controls:

1. Remote-control stations.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 26, Section 260943.13 “Addressable-Fixture Lighting Controls”.

2. Division 26, Section 260943.23 “Relay-Based Lighting Controls.”

C. Section Includes:

1. Electronic time switches.

2. Electromechanical dial-time switches.

3. Outdoor photoelectric switches, solid state, flexible mounting.

4. Outdoor photoelectric switches, solid state, luminaire-mounted.

5. Outdoor photoelectric switches, low voltage.

6. Daylight-harvesting switching controls.

7. Daylight-harvesting dimming controls, analog.

8. Daylight-harvesting dimming controls, digital.

9. Indoor occupancy and vacancy sensors.

10. Switchbox-mounted occupancy sensors.

11. Digital timer light switch.

12. High-bay occupancy sensors.

13. Extreme-temperature occupancy sensors.

14. Outdoor motion sensors.

15. Lighting contactors.

16. Emergency shunt relay.

17. Conductors and cables.

D. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.3 SUBMITTALS

A. Product Data for lighting control equipment and systems components, including dimensions and data on features and components. Include wiring diagrams and elevation views of front panels of control and indicating devices. Include data on ratings. For flush control panels, submit color and finish options for selection. Also include the following:

1. Operational documentation for software.

B. Shop Drawings detailing assemblies of standard components, custom assembled for specific application on Project. Indicate dimensions, weights, arrangement of components, and clearance and access requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show installation details for the following:
   a. Occupancy sensors.
   b. Vacancy sensors.

2. Interconnection diagrams showing field-installed wiring.

3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and elevations, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.

2. Structural members to which equipment will be attached.

3. Items penetrating finished ceiling, including the following:
    a. Luminaires.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Control modules.
    g. <Insert item>.

B. Field quality-control reports.

C. Sample Warranty: For manufacturer's warranties.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.

2. Program Software Backup: [On USB media] [On manufacturer's website]. Provide names, versions, and website addresses for locations of installed software.

3. Device address list.

4. Printout of software application and graphic screens.

1.7 QUALITY ASSURANCE

A. Comply with FCC Regulations of Part 15, Subpart J for Class A.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
    a. Faulty operation of lighting control software.
    b. Faulty operation of lighting control devices.
    c. <Insert failure modes>.

2. Warranty Period: [Two] <Insert number> year(s) from date of Substantial Completion.

B. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights The Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

C. Special Warranty: Submit a written warranty signed by manufacturer and Installer agreeing to replace programmable lighting control system components that fail in materials or workmanship within the specified warranty period.

1.9 EXTRA MATERIALS

A. Furnish extra products as described below that match the products installed, packaged with protective covering for storage, and identified with labels describing contents. Deliver extra materials to Owner.

1. Relays: Single-pole mechanically held, 1 for every 10 installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 ELECTRONIC TIME SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.

2. Intermatic, Inc.

3. Invensys Controls.

4. Leviton Manufacturing Co., Inc.

5. NSi Industries LLC.

6. TE Connectivity Ltd.

B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.

1. Listed and labeled as defined in NFPA 70 and marked for intended location and application.

2. Contact Configuration: **[SPST] [DPST] [DPDT] <Insert configuration>.**

3. Contact Rating: **[30-A inductive or resistive, 240-V ac] [20-A ballast load, 120-/240-V ac] <Insert rating>.**

4. Programs:
   a. Eight on-off set points on a 24-hour schedule[and an annual holiday schedule that overrides the weekly operation on holidays].
   b. Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week[and an annual holiday schedule that overrides the weekly operation on holidays].

c. <Insert number> channels; each channel is individually programmable with eight on-off set points on a 24-hour schedule.
d. <Insert number> channels; each channel is individually programmable with two on-off set points on a 24-hour schedule with a skip-a-day weekly schedule.
e. <Insert number> channels; each channel is individually programmable with two on-off set points on a 24-hour schedule, allowing different set points for each day of the week.
f. <Insert number> channels; each channel is individually programmable with 40 on-off operations per week and an annual holiday schedule that overrides the weekly operation on holidays.
g. <Insert number> channels; each channel is individually programmable with 40 on-off operations per week, plus four seasonal schedules that modify the basic program and an annual holiday schedule that overrides the weekly operation on holidays.
h. <Insert configuration>[and an annual holiday schedule that overrides the weekly operation on holidays].

5. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program[on selected channels].

6. Astronomic Time: [All] [Selected] channels.

7. Automatic daylight savings time changeover.

8. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

2.2 ELECTROMECHANICAL DIAL-TIME SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.

2. Intermatic, Inc.

3. Invensys Controls.

4. Leviton Manufacturing Co., Inc.

5. NSi Industries LLC.

6. TE Connectivity Ltd.

B. Electromechanical-Dial Time Switches: Comply with UL 917.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Contact Configuration: [SPST] [DPST] [SPDT] [DPDT] <Insert configuration>.

3. Contact Rating: [30-A inductive or resistive, 240-V ac] [20-A ballast load, 120-/240-V ac] <Insert rating>.

4. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.

5. Astronomic time dial.

6. Eight-Day Program: Uniquely programmable for each weekday and holidays.

7. Skip-a-day mode.

8. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of [16] <Insert number> hours.

2.3 OUTDOOR PHOTOELECTRIC SWITCHES, SOLID STATE, FLEXIBLE MOUNTING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.

2. Intermatic, Inc.

3. Leviton Manufacturing Co., Inc.

4. NSi Industries LLC.

5. TE Connectivity Ltd.

B. Description: Solid state, with [SPST] [DPST] <Insert configuration> dry contacts rated for [1000 W incandescent] [or] [1800 VA inductive] <Insert value>, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A, and compatible with ballasts and LED lamps.

1. Listed and labeled as defined in NFPA 70, by NRTL, and marked for intended location and application.

2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range[, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off].

3. Time Delay: Fifteen-second minimum, to prevent false operation.

4. Surge Protection: Metal-oxide varistor.

5. Mounting: Twist lock complies with ANSI C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure[from same source and manufacturer as switch].

6. Failure Mode: Luminaire stays ON.

2.4 OUTDOOR PHOTOELECTRIC SWITCHES, SOLID STATE, LUMINAIRE-MOUNTED

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. Leviton Manufacturing Co., Inc.
4. NSi Industries LLC.
5. TE Connectivity Ltd.

B. Description: Solid state, with [SPST] [DPST] dry contacts rated for [1000 W incandescent] [or] [1800 VA inductive], to operate connected load, complying with UL 773, and compatible with CFL and LED lamps.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
3. Time Delay: Thirty-second minimum, to prevent false operation.
4. Lightning Arrester: Air-gap type.
5. Mounting: Twist lock complying with ANSI C136.10, with base[from same source and manufacturer as switch].
6. Failure Mode: Luminaire stays ON.

2.5 OUTDOOR PHOTOELECTRIC SWITCHES, LOW VOLTAGE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. Leviton Manufacturing Co., Inc.
4. NSi Industries LLC.
5. TE Connectivity Ltd.

B. Description: Solid state; one set of NO dry contacts rated for [24 V dc at 1 A] [24 V ac at 1 A], to operate connected load, complying with UL 773, and compatible with [luminaire] [power pack] [lighting control panelboard].

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.

3. Time Delay: Thirty-second minimum, to prevent false operation.

4. Mounting: 1/2-inch threaded male conduit.

5. Failure Mode: Luminaire stays ON.

6. Power Pack:
   a. Dry contacts rated for [20-A] <Insert value> [ballast] [or] [LED] load at 120- and 277-V ac, for [13-A] <Insert value> tungsten at 120-V ac, and for [1 hp] <Insert value> at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
      1) LED status lights to indicate load status.
      2) Plenum rated.
   b. Digital controller capable of accepting [three] [four] <Insert number> RJ45 inputs with [one] [two] outputs rated for [20-A] <Insert value> incandescent[or LED] load at 120- and 277-V ac, for [13-A] [16-A] <Insert value> [ballast] [or] [LED] at 120- and 277-V ac, and for [1 hp] <Insert value> at 120-V ac. Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.
      1) With integral current monitoring.
      2) Compatible with digital addressable lighting interface.
      3) Plenum rated.

2.6 DAYLIGHT-HARVESTING SWITCHING CONTROLS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.

2. Eaton.

3. Hubbell Control Solutions; Hubbell Incorporated, Lighting.

4. Leviton Manufacturing Co., Inc.

5. Lithonia Lighting; Acuity Brands Lighting, Inc.

6. NSi Industries LLC.

7. Sensor Switch, Inc.

8. TE Connectivity Ltd.

9. WattStopper; Legrand North America, LLC.

B. Description: System operates indoor lighting.

C. Sequence of Operation: As daylight increases, the lights are turned off at a predetermined level. As daylight decreases, the lights are turned on at a predetermined level.

1. Lighting control set point is based on two lighting conditions:
   a. When no daylight is present.
   b. When significant daylight is present (target level).
   c. System programming is done with two hand-held, remote-control tools.

D. Ceiling-Mounted Switching Controls:

1. Solid-state, light-level sensor unit, with [integrated] power pack, that detects changes in indoor lighting levels that are perceived by the eye.

2. Solid-state, light-level sensor unit, with separate power pack[mounted on luminaire], that detects changes in indoor lighting levels that are perceived by the eye.

E. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.

3. Sensor Output:
   a. Contacts rated to operate the associated power pack, complying with UL 773A. Sensor shall be powered by the power pack.
   b. Digital signal compatible with power pack.

4. Sensor type: [Open loop] [Closed loop].

5. Zone: [Single] [Multi].

6. Power Pack:
   a. Dry contacts rated for [20-A] <Insert value> [ballast] [or] [LED] load at 120- and 277-V ac, for [13-A] <Insert value> tungsten at 120-V ac, and for [1 hp] <Insert value> at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
      1) LED status lights to indicate load status.
      2) Plenum rated.
   b. Digital controller capable of accepting [3] [4] <Insert number> RJ45 inputs with [one] [two] outputs rated for [20-A] <Insert value> incandescent[or] [LED] load at 120- and 277-V ac, for [13-A] [16-A] <Insert value> [ballast] [or LED]at 120- and 277-V ac, and for [1 hp] <Insert value> at 120-V ac. Sensor has 24-V dc Class 2 power source, as defined by NFPA 70.
      1) With integral current monitoring

2) Compatible with digital addressable lighting interface.
3) Plenum rated.

7. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc, with an adjustment for turn-on and turn-off levels within that range.

8. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1000 fc, with an adjustment for turn-on and turn-off levels within that range.

9. Skylight Sensors Light-Level Monitoring Range: 1000 to 10,000 fc, with an adjustment for turn-on and turn-off levels within that range.

10. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.

11. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.

12. Test Mode: User selectable, overriding programmed time delay to allow settings check.

13. Control Load Status: User selectable to confirm that load wiring is correct.

14. Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.7 DAYLIGHT-HARVESTING DIMMING CONTROLS, ANALOG

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.

2. Deep Roof Lighting.

3. Hubbell Control Solutions; Hubbell Incorporated, Lighting.

4. Leviton Manufacturing Co., Inc.

5. Lithonia Lighting; Acuity Brands Lighting, Inc.

6. WattStopper; Legrand North America, LLC.

B. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.

1. Lighting control set point is based on two lighting conditions:
   a. When no daylight is present (target level).
   b. When significant daylight is present.

2. System programming is done with two hand-held, remote-control tools.
   a. Initial setup tool.
   b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with [integrated] [separate] power pack[mounted on luminaire], to detect changes in indoor lighting levels that are perceived by the eye.

D. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Sensor Output: zero- to 10-V dc to operate luminaires. Sensor is powered by controller unit.

3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.

E. Power Pack: Dry contacts rated for [20-A] <Insert value> [ballast] [or] [LED] load at 120- and 277-V ac, for [13-A] <Insert value> tungsten at 120-V ac, and for [1 hp] <Insert value> at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

1. LED status lights to indicate load status.

2. Plenum rated.

2.8 DAYLIGHT-HARVESTING DIMMING CONTROLS, DIGITAL

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.

2. Deep Roof Lighting.

3. Hubbell Control Solutions; Hubbell Incorporated, Lighting.

4. Leviton Manufacturing Co., Inc.

5. Lithonia Lighting; Acuity Brands Lighting, Inc.

6. WattStopper; Legrand North America, LLC.

B. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, lights are dimmed.

1. Lighting control set point is based on the following two lighting conditions:
   a. When no daylight is present (target level).
   b. When significant daylight is present.

2. System programming is done with two hand-held, remote-control tools.
   a. Initial setup tool.
   b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with [integrated] [separate] power pack[mounted on luminaire], to detect changes in indoor lighting levels that are perceived by the eye.

D. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Sensor Output: zero- to 10-V dc to operate luminaires. Sensor is powered by controller unit.

3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.

E. Power Pack: Digital controller capable of accepting [three] [four] <Insert number> RJ45 inputs with [one] [two] output(s) rated for [20-A] <Insert value> incandescent [or] [LED] load at 120- and 277-V ac, for [13-A] [16-A] <Insert value> [ballast load] [or] [LED] at 120- and 277-V ac, and for [1 hp] <Insert value> at 120-V ac. Sensor has 24-V dc Class 2 power source, as defined by NFPA 70.

1. With integral current monitoring.

2. Compatible with digital addressable lighting interface.

3. Plenum rated.

2.9 INDOOR OCCUPANCY AND VACANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bryant Electric.

2. Cooper Industries, Inc.

3. Hubbell Control Solutions; Hubbell Incorporated, Lighting.

4. Intermatic, Inc.

5. Leviton Manufacturing Co., Inc.

6. Lithonia Lighting; Acuity Brands Lighting, Inc.

7. Lutron Electronics Co., Inc.

8. NSi Industries LLC.

9. RAB Lighting.

10. Sensor Switch, Inc.

11. WattStopper; Legrand North America, LLC.

B. General Requirements for Sensors:

1. [Wall] [Ceiling]-mounted, solid-state indoor [occupancy] [and] [vacancy] sensors.

2. [Passive infrared] [Ultrasonic] [Dual] technology.

3. [Integrated] [Separate] power pack.

4. [Hardwired] [Wireless] connection to switch[and BAS] [; and BAS and lighting control system].

5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

6. Operation:
   a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

7. Sensor Output: [Contacts rated to operate the connected relay, complying with UL 773A] [Sensor is powered from the power pack] [Wireless].

8. Power: [Line voltage] [Integral photovoltaic collector].

9. Power Pack: Dry contacts rated for 20-A [ballast] [or] [LED] load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

10. Mounting:
    a. Sensor: Suitable for mounting in any position on a standard outlet box.
    b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
    c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.

12. Bypass Switch: Override the "on" function in case of sensor failure.

13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.

C. PIR Type: [Wall] [Ceiling] mounted; detect occupants in coverage area by their heat and movement.

1. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in..

2. Detection Coverage (Room, Ceiling Mounted): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

3. Detection Coverage (Corridor, Ceiling Mounted): Detect occupancy within 90 feet when mounted on a 10-foot-high ceiling.

4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of [1000 square feet] [2000 square feet] [3000 square feet] when mounted 48 inches above finished floor.

D. Ultrasonic Type: [Wall] [Ceiling] mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.

2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch-high ceiling.

3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch-high ceiling.

5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot-high ceiling in a corridor not wider than 14 feet.

6. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of [1000 square feet] [2000 square feet] [3000 square feet] when mounted 84 inches above finished floor.

E. Dual-Technology Type: [Wall] [Ceiling] mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.

2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.

3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of [1000 square feet] [2000 square feet] [3000 square feet] when mounted 48 inches above finished floor.

2.10 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bryant Electric.
2. Cooper Industries, Inc.
3. Hubbell Control Solutions; Hubbell Incorporated, Lighting.
4. Intermatic, Inc.
5. Leviton Manufacturing Co., Inc.
6. Lithonia Lighting; Acuity Brands Lighting, Inc.
7. Lutron Electronics Co., Inc.
8. NSi Industries LLC.
9. RAB Lighting.
10. Schneider Electric USA (Square D).
11. Sensor Switch, Inc.
12. Signify North America Corporation (formerly Philips Lighting).
13. WattStopper; Legrand North America, LLC.

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox[, with provisions for connection to BAS] [using hardwired connection] [using wireless connection].

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application[, and shall comply with California Title 24].
2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
4. Switch Rating: Not less than 800-VA [ballast] [or] [LED] load at 120 V, 1200-VA [ballast] [or] [LED] load at 277 V, and 800-W incandescent.

C. Wall-Switch Sensor Tag WS1:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of [900 sq. ft.] [2100 sq. ft].

2. Sensing Technology: [PIR] [Dual technology - PIR and ultrasonic].

3. Switch Type: [SP.] [SP, dual circuit.] [SP, manual "on," automatic "off."] [SP, field-selectable automatic "on," or manual "on," automatic "off."]

4. Capable of controlling load in three-way application.

5. Voltage: [Match the circuit voltage] [120 V] [277 V] [Dual voltage - 120 and 277 V].

6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.

7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.

8. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.

9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

10. Color: [White] [Black] <Insert color>.

11. Faceplate: Color matched to switch.

D. Wall-Switch Sensor Tag WS2:

1. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft..

2. Sensing Technology: PIR.

3. Switch Type: [SP.] [SP, dual circuit.] [SP, manual "on," automatic "off."] [SP, field-selectable automatic "on," or manual "on," automatic "off."]

4. Capable of controlling load in three-way application.

5. Voltage: [Match the circuit voltage] [120 V] [277 V] [Dual voltage, 120 and 277 V].

6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.

7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.

8. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.

9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

10. Color: [White] [Black] <Insert color>.

11. Faceplate: Color matched to switch.

2.11 DIGITAL TIMER LIGHT SWITCH

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.

2. Intermatic, Inc.

3. Invensys Controls.

4. Leviton Manufacturing Co., Inc.

5. NSi Industries LLC.

6. TE Connectivity Ltd.

B. Description: Combination digital timer and conventional switch lighting control unit. Switchbox-mounted, backlit LCD display, with selectable time interval in [10] [20] minute increments.

1. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.

2. Standards: Comply with UL 20.

3. Integral relay for connection to BAS.

4. Voltage: [Match the circuit voltage] [120 V] [277 V] [Dual voltage - 120 and 277 V].

5. Color: [White] [Black] <Insert color>.

6. Faceplate: Color matched to switch.

2.12 HIGH-BAY OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Control Solutions; Hubbell Incorporated, Lighting.

B. Description: Solid-state unit. The unit is designed to operate with the lamp and ballasts indicated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.

3. Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.

4. Power: Line voltage.

5. Operating Ambient Conditions: 32 to 149 deg F.

6. Mounting: Threaded pipe.

7. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

8. Detector Technology: PIR.

9. Power and dimming control from the luminaire ballast that has been modified to include the dimming capacitor[and MyzerPORT option].

C. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet.

D. Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

2.13 EXTREME-TEMPERATURE OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.

2. Sensor Switch, Inc.

B. Description: Ceiling-mounted, solid-state, extreme-temperature occupancy sensors with a separate power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended application in damp locations.

2. Operation: Turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.

3. Operating Ambient Conditions: From minus 40 to plus 125 deg F.

4. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.

5. Power Pack: Dry contacts rated for 20-A [ballast] [or] [LED] load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

6. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind cover.

7. Bypass Switch: Override the "on" function in case of sensor failure.

8. Automatic Light-Level Sensor: Adjustable from 2 to 10 fc; keep lighting off when selected lighting level is present.

C. Detector Technology: PIR. Ceiling mounted; detect occupants in coverage area by their heat and movement.

1. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in..

2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1500 sq. ft. when mounted on a 96-inch-high ceiling.

3. Detection Coverage (High Bay): Detect occupancy within 25 feet when mounted on a 25-foot-high ceiling.

2.14 OUTDOOR MOTION SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bryant Electric.

2. Cooper Industries, Inc.

3. Hubbell Control Solutions; Hubbell Incorporated, Lighting.

4. Leviton Manufacturing Co., Inc.

5. Lithonia Lighting; Acuity Brands Lighting, Inc.

6. NSi Industries LLC.

7. RAB Lighting.

8. Sensor Switch, Inc.

9. WattStopper; Legrand North America, LLC.

B. Description: Solid-state outdoor motion sensors.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application[, and shall comply with California Title 24].

2. [PIR] [Dual-technology (PIR and ultrasonic)] type, weatherproof. Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.. Comply with UL 773A.

3. Switch Rating:
   a. Luminaire-Mounted Sensor: [1000-W incandescent, 500-VA fluorescent/LED] <Insert rating>.
   b. Separately Mounted Sensor: Dry contacts rated for 20-A [ballast] [or] [LED] load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

4. Switch Type: [SP.] [SP, dual circuit.] [SP, manual "on," automatic "off."] [SP, field-selectable automatic "on," or manual "on," automatic "off."][With bypass switch to override the "on" function in case of sensor failure.]

5. Voltage: [Match the circuit voltage] [120-V] [277-V] [Dual voltage, 120- and 277-V] type.

6. Detector Coverage:
   a. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft..
   b. Long Range: 180-degree field of view and 110-foot detection range.
   c. <Insert coverage area>.

7. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.

8. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.

9. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.

10. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and help eliminate false "off" switching.

11. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F, rated as "raintight" according to UL 773A.

2.15 LIGHTING CONTACTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB (Electrification Products Division).

2. Allen-Bradley/Rockwell Automation.

3. ASCO Power Technologies.

4. Eaton.

5. Leviton Manufacturing Co., Inc.

6. Schneider Electric USA (Square D).

B. Description: Electrically operated and [mechanically] [electrically] held, combination-type lighting contactors with [fusible switch] [nonfused disconnect], complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).

2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.

3. Enclosure: Comply with NEMA 250.

4. Provide with control and pilot devices as [indicated on Drawings] [scheduled], matching the NEMA type specified for the enclosure.

C. Interface with DDC System for HVAC: Provide hardware interface to enable the DDC system for HVAC to monitor and control lighting contactors.

1. Monitoring: On-off status, <Insert monitoring point>.

2. Control: On-off operation, <Insert control point>.

2.16 EMERGENCY SHUNT RELAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Lighting Control and Design.

2. WattStopper; Legrand North America, LLC.

B. Description: NC, electrically held relay, arranged for wiring in parallel with manual [or automatic]switching contacts; complying with UL 924.

1. Coil Rating: [120] [277] V.

2.17 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than [No. 18] [No. 22] [No. 24] AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than [No. 14] [No. 16] [No. 18] AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

2.18 LIGHTING CONTROL EQUIPMENT, GENERAL

A. Include line-voltage surge protection in all solid-state equipment. Comply with UL 1449 and ANSI C62.41.

2.19 TIME SWITCHES

A. Time Switches: Include the following features;

1. Pilot-Duty Contacts: 2, rated 2 A at 240 V, except as otherwise indicated.

2.20 PHOTOELECTRIC RELAYS

A. Indoor Ceiling- or Wall-Mounted Units: Semiflush, calibrated to detect adequacy of daylighting in perimeter locations and arranged to turn artificial illumination on and off to suit varying intensities of available daylighting. Units are adjustable for turn-on/turn-off levels.

B. Indoor Skylight Units: Housed in a threaded plastic fitting for mounting under skylight, suitable for monitoring light levels from 0 to 3500 foot candles (0 to 37673 lux).

C. Outdoor Sealed Units: Weathertight housing, resistant to high temperatures and equipped with sun glare shield and ice preventer.

2.21 OCCUPANCY SENSORS

A. General: Connected to receive power from and operate a light switching relay in a separately mounted auxiliary power control unit, except as otherwise indicated.

B. Operation:

1. Isolated Relay Contact: Operates on detection of occupancy to activate an independent function.

2.22 LOW-VOLTAGE WIRING

A. Digital and Multiplexed Signal Wire: Shielded, twisted-pair cable.

B. Low-Voltage Control Cable” Multiple conductor, color coded, No. 20 AWG copper.

1. Sheath: Polyvinyl chloride (PVC), except in plenum-Type spaced. In plenum-type spaces, use sheath listed for such use.

2. Ordinary Switch Circuits: 3 conductors, except as otherwise indicated.

3. Switch Circuits with Pilot Lights or Locator Feature: 5 conductors, except as otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Mounting heights indicated are to bottom of unit for suspended items and to center of unit for wall-mounted ones.

3.3 INSTALLATION OF SENSORS

A. Comply with NECA 1.

B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

C. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.4 INSTALLATION OF CONTACTORS

A. Comply with NECA 1.

B. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.5 INSTALLATION OF WIRING

A. Comply with NECA 1.

B. Bundle, train, and support wiring in enclosures.

C. Grounding: Ground equipment. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

D. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.

E. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's written instructions.

F. Size conductors in accordance with lighting control device manufacturer's written instructions unless otherwise indicated.

G. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.6 IDENTIFICATION

A. Make designations on elevated components readable from floor.

B. Identify components and power and control wiring in accordance with Section 260553 "Identification for Electrical Systems.

1. Identify controlled circuits in lighting contactors.

2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

C. Label time switches and contactors with a unique designation.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to evaluate lighting control devices and perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[with the assistance of a factory-authorized service representative]:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Lighting control devices will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

F. Reports: Prepare written reports of tests and observations. Report defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

G. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible organization and person.

H. Schedule visual and mechanical inspections and electrical tests with at least 7 days' advance notice.

I. Visual and Operational Inspections: Include the following inspections.

1. Inspect control components for defects and physical damage, NRTL labeling, and nameplate compliance with current Project Drawings.

2. Check tightness of electrical connections with torque wrench calibrated within previous 6 months. Use manufacturers recommended torque values.

3. Verify settings of photoelectric devices with photometer calibrated to National Institute for Science and Technology (NIST) standards within past 6 months.

4. Exercise and perform operational tests on mechanical parts and operable devices according to manufacturer's instructions for routine functional operation.

J. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform the following tests according to manufacturer's instructions.

1. Continuity tests of circuits.

2. Operational Tests: Set and operate controls to demonstrate controls in a methodical sequence that cues and reproduces actual operating functions. Include testing of dimming equipment and ambient-light, programmable, and occupancy controls under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

K. Correct deficiencies disclosed by inspections and tests, make necessary adjustments, and retest deficient items. Verify that specified requirements are met.

3.8 ADJUSTING AND CLEANING

A. Occupancy Adjustments: When requested within [12] <Insert number> months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to [two] <Insert number> visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

B. Repair scratches and mars of finish to match original finish. Clean equipment and devices internally and externally using methods and materials recommended by manufacturers.

3.9 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for [two] <Insert number> years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within [two] <Insert number> years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least [30] <Insert number> days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 260943.16 "Addressable-Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls."

B. [Engage a factory-authorized service representative to train] [Train] Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 0923

SECTION 262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution, dry-type transformers with nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.

b. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.

2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.

3. Include diagrams for power, signal, and control wiring.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Seismic Qualification Data: Certificates, for transformers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

4. Certification: Indicate that equipment meets Project seismic requirements.

C. Source quality-control reports.

D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note shipping damage to packaging and transformer.

1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in warm, dry, and temperature-stable location in original shipping packaging.

C. Temporary Heating: Apply temporary heat in accordance with manufacturer's published instructions within enclosure of ventilated-type units, throughout periods during which equipment is not energized and when transformer is not in space that is continuously under normal control of temperature and humidity.

D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acme Electric Corporation.
2. Controlled Power Company; an Emerson company.
3. Dongan Electric Manufacturing Company.
4. Eaton.
5. Federal Pacific.
6. General Electric Company.
7. Hammond Power Solutions Inc.
8. Jefferson Electric, Inc.
9. Lincoln Electric Products Co., Inc.
10. Mag-Tran; a division of Quality Transformer & Electronics.
11. Marcus Transformer LTD.
12. MGM Transformer Company.
13. Micron Industries Corporation.
14. Mirus International Inc.

B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Transformers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the transformer will remain in place without separation of any parts when subjected to the seismic forces specified and the transformer will be fully operational after the seismic event."

2.3 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60 Hz service.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. Transformers Rated 15 kVA and Larger:

1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.

2. Marked as compliant with DOE 2016 efficiency levels by qualified electrical testing laboratory recognized by authorities having jurisdiction.

D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside transformer enclosure.

2.4 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70, and list and label as complying with UL 1561.

B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

1. One leg per phase.

2. Core volume must allow efficient transformer operation at 10 percent above nominal tap voltage.

3. Grounded to enclosure.

C. Coils: Continuous windings without splices except for taps.

1. Coil Material: Copper.

2. Internal Coil Connections: Brazed or pressure type.

3. Terminal Connections: Bolted.

D. Encapsulation: Transformers smaller than 30 kVA must have core and coils completely resin encapsulated.

E. Enclosure: Ventilated.

1. Core and coil must be encapsulated within resin compound using vacuum-pressure impregnation process to seal out moisture and air.

2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.

3. Wiring Compartment: Sized for conduit entry and wiring installation.

4. Environmental Protection:

a. Indoor: UL 50E, Type 2.

b. Outdoor: UL 50E, Type 3R.

5. Finish Color: ANSI 49 gray weather-resistant enamel.

F. Taps for Transformers 3 kVA and Smaller: One 5 percent tap above normal full capacity.

G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity

I. See "Insulation Ratings" Article in the Evaluations for discussion of insulation classes. See "Energy Considerations" Article in the Evaluations for discussion of relative efficiencies. Temperature rise of 115 or 80 deg C only applies to transformers 15 kVA and larger.

J. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.

K. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with maximum of 150 deg C rise above 40 deg C ambient temperature.

L. Grounding: Provide ground-bar kit or ground bar installed on inside of transformer enclosure.

M. K-Factor Rating: Transformers indicated to be K-factor rated must comply with UL 1561 requirements for nonsinusoidal load current-handling capability to degree defined by designated K-factor.

1. Unit may not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding indicated insulation class in 40 deg C maximum ambient and 24-hour average ambient of 30 deg C.

2. Indicate value of K-factor on transformer nameplate.

3. Unit must comply with requirements of DOE 2016 efficiency levels when tested in accordance with NEMA TP 2 with K-factor equal to one.

N. Electrostatic Shielding: Windings must have independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.

2. Include special terminal for grounding shield.

O. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.

P. Wall Brackets: Manufacturer's standard brackets.

Q. Low-Sound-Level Requirements: Maximum sound levels when factory tested in accordance with IEEE C57.12.91, as follows:

1. 9.00 kVA and Less: 40 dBA

2. 9.01 to 30.00 kVA: 45 dBA.

3. 30.01 to 50.00 kVA: 45 dBA-weighted for K-factors of 4, and , 48 dBA for K-factors of 13 and 20.

4. 50.01 to 150.00 kVA: 50 dBA for K-factors of 4, and 9, 53 dBA for K-factors of 13 and 20.

5. 150.01 to 300.00 kVA: 55 dBA for K-factors of 4, and 9, 58 dBA for K-factors of 13 and 20.

6. 300.01 to 500.00 kVA: 60 dBA for K-factors of 4, and 9, 63 dBA for K-factors of 13 and 20.

2.5 IDENTIFICATION

A. Nameplates:

1. Engraved, laminated-acrylic or melamine plastic signs for distribution transformers, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2. Self-adhesive label for distribution transformers. Self-adhesive labels are specified in Section 260553 "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

A. Tests and Inspections: Test and inspect assembled system, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with IEEE C57.12.01 and IEEE C57.12.91 before delivering to site. Affix label with name and date of manufacturer's qualified electrical testing laboratory's certification of system compliance on control units.

1. Resistance measurements of windings at rated voltage connections and at tap connections.

2. Ratio tests at rated voltage connections and at tap connections.

3. Phase relation and polarity tests at rated voltage connections.

4. No load losses, and excitation current and rated voltage at rated voltage connections.

5. Impedance and load losses at rated current and rated frequency at rated voltage connections.

6. Applied and induced tensile tests.

7. Regulation and efficiency at rated load and voltage.

8. Insulation-Resistance Tests:

   a. Line-side to ground.

   b. Load-side to ground.

   c. Line-side to load-side.

9. Temperature tests.

10. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

B. Nonconforming Work:

1. System equipment that does not pass tests and inspections will be considered defective.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for transformers.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's published instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5 Ω at location of transformer.

E. Environment: Enclosures must be rated for environment in which they are located. Covers for UL 50E, Type 4X enclosures may not cause accessibility problems.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer from design drawings signed and sealed by qualified structural professional engineer.

1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.

2. Brace wall-mounted transformers as specified in Section 260548 "Seismic Controls for Electrical Systems".

B. Install transformers level and plumb on concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

C. Construct housekeeping concrete bases and anchor floor-mounted transformers in accordance with manufacturer's published instructions**,** seismic requirements applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

D. Secure transformer to concrete base in accordance with manufacturer's published instructions.

E. Secure covers to enclosure and tighten bolts to manufacturer-recommended torques to reduce noise generation.

F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Provide flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

3.4 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by Architect, authorities having jurisdiction.

B. Tests and Inspections:

1. Small (Up to 167 kVA Single-Phase or 500 kVA Three-Phase) Dry-Type Transformer Field Tests:

a. Visual and Mechanical Inspection.

1) Inspect physical and mechanical condition.

2) Inspect anchorage, alignment, and grounding.

3) Verify that resilient mounts are free and that shipping brackets have been removed.

4) Verify that unit is clean.

5) Perform specific inspections and mechanical tests recommended by manufacturer.

6) Verify that as-left tap connections are as specified.

7) Verify presence of surge arresters and that their ratings are as specified.

b. Electrical Tests:

1) Measure resistance at windings, taps, and bolted connections.

2) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: value of index may not be less than 1.0.

3) Perform turns-ratio tests at tap positions. Test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.

4) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

2. Large (Larger Than 167 kVA Single Phase or 500 kVA Three Phase) Dry-Type Transformer Field Tests:

a. Visual and Mechanical Inspection:

1) Inspect physical and mechanical condition.

2) Inspect anchorage, alignment, and grounding.

3) Verify that resilient mounts are free and that shipping brackets have been removed.

4) Verify that unit is clean.

5) Perform specific inspections and mechanical tests recommended by manufacturer.

6) Verify that as-left tap connections are as specified.

7) Verify presence of surge arresters and that their ratings are as specified.

b. Electrical Tests:

1) Measure resistance at windings, taps, and bolted connections.

2) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: value of index may not be less than 1.0.

3) Perform power-factor or dissipation-factor tests on windings.

4) Perform turns-ratio tests at tap positions. Test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.

5) Perform excitation-current test on each phase.

6) Perform applied voltage test on line- and load-side windings to ground. See IEEE C57.12.91, Sections 10.2 and 10.9.

7) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

C. Test Labeling: On completion of satisfactory testing of units, attach dated and signed "Satisfactory Test" label to tested components.

D. Nonconforming Work:

1. Transformer will be considered defective if it does not pass tests and inspections.

2. Remove and replace units that do not pass tests or inspections and retest as specified above.

E. Assemble and submit test and inspection reports.

F. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

3.5 ADJUSTING

A. Record transformer secondary voltage at unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.7 MAINTENANCE

A. Infrared Scanning: Two months after Substantial Completion, perform infrared scan of transformer connections.

1. Use infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.

2. Perform two follow-up infrared scans of transformers, one at four months and another at 11 months after Substantial Completion.

3. Prepare certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 26 2213

SECTION 26 2413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.

2. Surge protection devices.

3. Disconnecting and overcurrent protective devices.

4. Instrumentation.

5. Control power.

6. Accessory components and features.

7. Identification.

8. Mimic bus.

B. Related Requirements

1. Section 260573 “Electrical Systems Studies” for arc-flash analysis and arc-flash label requirements.

1.3 ACTION SUBMITTALS

A. All studies will be incorporated into the gear submittal for, but not limited to Switchboards and panelboards. Electrical gear will not be reviewed without the incorporation of the coordination and other studies needed to provide a complete gear submittal.

B. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.

1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

C. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.

2. Detail enclosure types for types other than NEMA 250, Type 1.

3. Detail bus configuration, current, and voltage ratings.

4. Detail short-circuit current rating of switchboards and overcurrent protective devices.

5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.

6. Detail utility company's metering provisions with indication of approval by utility company.

7. Include evidence of NRTL listing for series rating of installed devices.

8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

10. Include diagram and details of proposed mimic bus.

11. Include schematic and wiring diagrams for power, signal, and control wiring.

D. Samples: Representative portion of mimic bus with specified material and finish, for color selection.

E. Delegated Design Submittal:

1. For arc-flash hazard analysis.

2. For arc-flash labels.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Seismic Qualification Data: Certificates, for switchboards, overcurrent protective devices, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field Quality-Control Reports:

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Routine maintenance requirements for switchboards and all installed components.

b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.

2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.

4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.

5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.

6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section). Connect factory-installed space heaters to temporary electrical service to prevent condensation. This will be for any switchboard installed exterior to the building.

C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.9 FIELD CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weather tight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 104 deg F.

b. Altitude: Not exceeding 6600 feet.

C. Unusual Service Conditions: NEMA PB 2, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet.

D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify **Architect** no fewer than **seven** days in advance of proposed interruption of electric service.

2. Indicate method of providing temporary electric service.

3. Do not proceed with interruption of electric service without Architect's, Construction Manager's, and Owner's written permission.

4. Comply with NFPA 70E.

1.10 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7**.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.

2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 SWITCHBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Schneider Electric USA (Square D)

2. Siemens Industry, Inc., Energy Management Division

3. Eaton.

4. ABB (Electrification Products Division).

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 2.

F. Comply with NFPA 70.

G. Comply with UL 891.

H. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.

2. Branch Devices: Panel mounted.

3. Sections front and rear aligned.

I. Nominal System Voltage: 480Y/277V and 208Y/120V.

J. Main-Bus Continuous: up to 2400A. Or as noted on drawings.

K. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

L. Indoor Enclosures: Steel, NEMA 250, Type 1.

M. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

N. Outdoor Enclosures: Type 3R.

1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.

2. Enclosure: Flat roof; bolt-on rear covers for each section, with provisions for padlocking.

3. Doors: Personnel door at each end of aisle, minimum width of 36 inches opening outwards; with panic hardware and provisions for cylinder lock. At least one door shall be sized to permit the largest single switchboard section to pass through without disassembling doors, hinges, or switchboard section.

4. Power for space heaters, ventilation, lighting, and receptacle provided by a remote source.

O. Barriers: Between adjacent switchboard sections.

P. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

Q. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.

1. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.

2. Space-Heater Power Source: 120-V external branch circuit.

R. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

S. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.

T. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

U. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

V. Pull Box on Top of Switchboard:

1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.

2. Set back from front to clear circuit-breaker removal mechanism.

3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.

4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.

5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

W. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.

2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated.

3. Phase- and Neutral-Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.

4. Copper feeder circuit-breaker line connections.

5. Tin-plated aluminum feeder circuit-breaker line connections.

6. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with compression connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.

7. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with compression connectors for feeder and branch-circuit ground conductors.

8. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.

9. Disconnect Links:

   a. Isolate neutral bus from incoming neutral conductors.

   b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.

10. Neutral Buses: 50 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

11. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

12. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

X. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

Y. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

Z. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.

2.3 SURGE PROTECTION DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Schneider Electric USA (Square D)

2. Siemens Industry, Inc., Energy Management Division

3. Eaton

4. Advanced Protection Technologies Inc. (APT)

5. ABB (Electrification Products Division).

B. SPDs: Comply with UL 1449, Type 1.

C. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1.

D. Features and Accessories:

1. Integral disconnect switch.

2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.

3. Indicator light display for protection status.

4. Form-C contacts rated at 2 A and 24-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge

diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

5. Surge counter.

E. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 300 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

F. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 2400 V for 480Y/277 V, 700 V for 208Y/120 V.

2. Line to Ground: 1200 V for 480Y/277 V, 1200 V for 208Y/120 V.

3. Line to Line: 2400 V for 480Y/277 V, 1000 V for 208Y/120 V.

G. SCCR: Equal or exceed 200 kA.

H. Nominal Rating: 20 kA.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with series-connected rating interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

a. Instantaneous trip.

b. Long- and short-time pickup levels.

c. Long and short time adjustments.

d. Ground-fault pickup level, time delay, and I squared t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.

6. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).

7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).

8. MCCB Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.

    b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor material.

    c. Application Listing: Appropriate for application; Type SWD for switching LED lighting loads;

    d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

    e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

    f. Communication Capability: Universal-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."

    g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

    h. Under voltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

    i. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.

1. Fixed circuit-breaker mounting.

2. Two-step, stored-energy closing.

3. Full-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:

    a. Instantaneous trip.

    b. Time adjustments for long- and short-time pickup.

    c. Ground-fault pickup level, time delay, and I squared t response.

4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

5. Remote trip indication and control.

6. Communication Capability: Web enabled integral Ethernet communication module and embedded Web server with factory-configured Web pages (HTML file format). Provide functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."

7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

8. Control Voltage: 120-V ac.

C. Bolted-Pressure Contact Switch: Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Schneider Electric USA (Square D)

   b. Siemens Industry, Inc., Energy Management Division

   c. Eaton.

   d. Boltswitch, Inc.

2. Main-Contact Interrupting Capability: Minimum of 12 times the switch current rating.

3. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.

   a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.

   b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.

4. Auxiliary Switches: Factory installed, SPDT, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.

5. Service-Rated Switches: Labeled for use as service equipment.

6. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.

   a. Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

b. Internal Memory: Integrates the cumulative value of intermittent arcing ground-fault currents and uses the effect to initiate tripping.

c. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.

d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).

7. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.

D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

E. Fuses are specified in Section 262813 "Fuses."

2.5 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, and the following:

1. Potential Transformers: NEMA EI 21.1; 120 V, 60 Hz, double secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.

2. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary; bushing type; double secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.

3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.

4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

a. Phase Currents, Each Phase: Plus or minus 0.5 percent.

b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.

c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.

d. Megawatts: Plus or minus 1 percent.

e. Megavars: Plus or minus 1 percent.

f. Power Factor: Plus or minus 1 percent.

g. Frequency: Plus or minus 0.1 percent.

h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.

i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.

j. Contact devices to operate remote impulse-totalizing demand meter.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

C. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.

D. Instrument Switches: Rotary type with off position.

1. Voltmeter Switches: Permit reading of all phase-to-phase voltages and, where a neutral is indicated, phase-to-neutral voltages.

2. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in a closed-circuit condition at all times.

E. Ammeters: 2-1/2-inch minimum size with 90- or 120-degree scale. Meter and transfer device with off position, located on overcurrent device door for indicated feeder circuits only.

F. Watt-Hour Meters and Wattmeters:

1. Comply with ANSI C12.1.

2. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.

3. Suitable for connection to three- and four-wire circuits.

4. Potential indicating lamps.

5. Adjustments for light and full load, phase balance, and power factor.

6. Four-dial clock register.

7. Integral demand indicator.

8. Contact devices to operate remote impulse-totalizing demand meter.

9. Ratchets to prevent reverse rotation.

10. Removable meter with drawout test plug.

11. Semiflush mounted case with matching cover.

12. Appropriate multiplier tag.

G. Impulse-Totalizing Demand Meter:

1. Comply with ANSI C12.1.

2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.

3. Cyclometer.

4. Four-dial, totalizing kilowatt-hour register.

5. Positive chart drive mechanism.

6. Capillary pen holding a minimum of one month's ink supply.

7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.

8. Capable of indicating and recording 30-minute integrated demand of totalized system.

2.6 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Control Circuits: 120-V ac, supplied from remote branch circuit.

C. Control Circuits: 24V dc.

D. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.

E. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

F. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

C. Portable Circuit-Breaker Lifting Device: Floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.

D. Overhead Circuit-Breaker Lifting Device: Mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.

E. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

F. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems" or manufacturer's instructions.

2.8 IDENTIFICATION

A. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on a photoengraved nameplate.

1. Nameplate: At least 0.032-inch-thick anodized aluminum, located at eye level on front cover of the switchboard incoming service section.

B. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on an engraved laminated-plastic (Gravoply) nameplate.

1. Nameplate: At least 0.0625-inch-thick laminated plastic (Gravoply), located at eye level on front cover of the switchboard incoming service section.

C. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram.

D. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.

E. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

F. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.

2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.

3. Protect from moisture, dust, dirt, and debris during storage and installation.

4. Install temporary heating during storage per manufacturer's instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after switchboard is anchored in place.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to switchboards.

6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices, surge protection devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

H. Install spare-fuse cabinet.

I. Comply with NECA 1.

3.3 CONNECTIONS

A. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

B. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.

C. Support and secure conductors within the switchboard according to NFPA 70.

D. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:

1. Acceptance Testing:

a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.

b. Test continuity of each circuit.

2. Test ground-fault protection of equipment for service equipment per NFPA 70.

3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

5. Perform the following infrared scan tests and inspections, and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.

c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Electrical Systems Studies".

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 26 2413

SECTION 26 2416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards.

2. Lighting and appliance branch-circuit panelboards.

3. Load centers.

1.3 DEFINITIONS

A. ATS: Acceptance testing specification.

B. GFCI: Ground-fault circuit interrupter.

C. GFEP: Ground-fault equipment protection.

D. HID: High-intensity discharge.

E. MCCB: Molded-case circuit breaker.

F. SPD: Surge protective device.

G. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

A. All studies will be incorporated into the gear submittal for, but not limited to Switchboards and panelboards. Electrical gear will not be reviewed without the incorporation of the coordination and other studies needed to provide a complete gear submittal

B. Product Data: For each type of panelboard.

1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.

2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

C. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.

2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.

3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.

4. Detail bus configuration, current, and voltage ratings.

5. Short-circuit current rating of panelboards and overcurrent protective devices.

6. Include evidence of NRTL listing for series rating of installed devices.

7. Include evidence of NRTL listing for SPD as installed in panelboard.

8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

9. Include wiring diagrams for power, signal, and control wiring.

10. Key interlock scheme drawing and sequence of operations.

11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.

2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.

3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.8 EXTRA MATERIALS

A. Touch-Up Paint: One half pint container for enclosures and fronts.

1.9 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or ISO 9002 certified.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.11 FIELD CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.

b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect no fewer than Seven days in advance of proposed interruption of electric service.

2. Do not proceed with interruption of electric service without Architect's, and Owner's written permission.

3. Comply with NFPA 70E.

1.12 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.

1. SPD Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

F. Enclosures: Surface-mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

b. Outdoor Locations: NEMA 250, Type 3R.

c. Kitchen, Wash-Down Areas: NEMA 250, Type 4X.

d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

2. Height: 84 inches maximum.

3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.

4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.

5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.

7. Finishes:

a. Panels and Trim: galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

b. Back Boxes: Same finish as panels and trim.

c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

G. Incoming Mains:

1. Location: Convertible between top and bottom.

2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

H. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

a. Plating shall run entire length of bus.

b. Bus shall be fully rated the entire length.

2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.

3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.

5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.

7. Split Bus: Vertical buses divided into individual vertical sections.

8. <Insert optional features>.

I. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.

2. Terminations shall allow use of 75 deg C rated conductors without de-rating.

3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.

4. Main and Neutral Lugs: Compression type, with a lug on the neutral bar for each pole in the panelboard.

5. Ground Lugs and Bus-Configured Terminators: Compression type, with a lug on the bar for each pole in the panelboard.

6. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

7. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

8. Gutter-Tap Lugs: Compression type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.

9. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

J. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

K. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. Percentage of Future Space Capacity: 20 percent.

L. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.

1. Panelboards rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.

2. Panelboards rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

M. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.

2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.3 POWER PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Schneider Electric USA (Square D)
2. Siemens Industry, Inc., Energy Management Division
3. Eaton.
4. ESL Power Systems, Inc
5. Mersen USA.
6. ABB (Electrification Products Division).

B. Panelboards: NEMA PB 1, distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: Circuit breaker or Lugs only.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

G. Branch Overcurrent Protective Devices: Fused switches.

H. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
2. External Control-Power Source: 24-V control circuit>.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Schneider Electric USA (Square D).
2. Siemens Industry, Inc., Energy Management Division.
3. Eaton.

4. Bender Inc / Isotrol.

5. ABB (Electrification Products Division).

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker and or lugs only.

D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

E. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

2. External Control-Power Source: 24-V control circuit.

F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

G. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

H. Column-Type Panelboards: Single row of overcurrent devices with narrow gutter extension and overhead junction box equipped with ground and neutral terminal buses.

1. Doors: Concealed hinges secured with multipoint latch with tumbler lock; keyed alike.

2.5 LOAD CENTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Schneider Electric USA (Square D)

2. Siemens Industry, Inc., Energy Management Division

3. Eaton.

4. ABB (Electrification Products Division).

B. Load Centers: Comply with UL 67.

C. Mains: Circuit breaker and or lugs only.

D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges secured with flush latch with tumbler lock; keyed alike.

F. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.6 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Schneider Electric USA (Square D).
2. Siemens Industry, Inc., Energy Management Division.
3. Eaton.
4. ABB (Electrification Products Division).

B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:
    a. Inverse time-current element for low-level overloads.
    b. Instantaneous magnetic trip element for short circuits.
    c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Circuit Breakers:
    a. RMS sensing.
    b. Field-replaceable rating plug or electronic trip.
    c. Digital display of settings, trip targets, and indicated metering displays.
    d. Multi-button keypad to access programmable functions and monitored data.
    e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.

f. Integral test jack for connection to portable test set or laptop computer.

g. Field-Adjustable Settings:

1) Instantaneous trip.

2) Long- and short-time pickup levels.

3) Long and short time adjustments.

4) Ground-fault pickup level, time delay, and I squared T response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).

6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).

7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.

8. Subfeed Circuit Breakers: Vertically mounted.

9. Molded-Case Circuit Breaker

a. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.

b. Circuit Breakers, 400 A and Larger: Field-adjustable short-time and continuous current settings

c. Current Limiters: Where indicated, integral fuse listed for circuit breaker.

10. MCCB Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.

b. Breaker handle indicates tripped status.

c. UL listed for reverse connection without restrictive line or load ratings.

d. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.

e. Application Listing: Appropriate for application; Type SWD for switching LED lighting loads circuits.

f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

g. Communication Capability: Universal-mounted communication module with functions and features compatible with power monitoring and control system. .

h. Shunt Trip: 24-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

i. Under voltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.

j. Rating Plugs: Three-pole breakers with ampere ratings greater than **150** amperes shall have interchangeable rating plugs or electronic adjustable trip units.

k. Auxiliary Contacts: Two, SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.

l. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.

m. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

n. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.

o. Multipole units enclosed in a [single housing with a single handle] [or] [factory assembled to operate as a single unit].

p. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.

q. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."

2. Fused Switch Features and Accessories:

a. Standard ampere ratings and number of poles.

b. Mechanical cover interlock with a manual interlock override, to prevent the opening of the cover when the switch is in the on position. The interlock shall prevent the switch from being turned on with the cover open. The operating handle shall have lock-off means with provisions for three padlocks.

c. Auxiliary Contacts: Two normally open and normally closed contact(s) that operate with switch handle operation.

2.7 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Directory card inside panelboard door, mounted in metal frame with transparent protective cover.

1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.8 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Comply with NECA 1.

C. Install panelboards and accessories according to NEMA PB 1.1.

D. Equipment Mounting:

1. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

2. Attach panelboard to the vertical finished or structural surface behind the panelboard.

3. Comply with requirements for seismic control devices specified in Section 260548 "Seismic Controls for Electrical Systems."

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

G. Mount top of trim 90 inches above finished floor unless otherwise indicated.

H. Mount panelboard cabinet plumb and rigid without distortion of box.

I. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

J. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.

K. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

L. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

M. Install filler plates in unused spaces.

N. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

O. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

P. Mount spare fuse cabinet in accessible location.

3.3 IDENTIFICATION

A. Labels for identifying the breakers shall be engraved laminated plastic strips attached by screws or Phenolic buttons or small window frame type. Adhesive stick-on labels will not be acceptable.

B. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

C. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

D. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

E. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

F. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:

   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.

   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.

   c. Instruments and Equipment:

      1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Electrical System Studies."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.

1. Measure loads during period of normal facility operations.

2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.

4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

Consider the following:

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.7 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 2416

SECTION 26 2726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General-use switches, dimmer switches, and fan-speed controller switches.
2. General-grade single straight-blade receptacles.
3. General-grade duplex straight-blade receptacles.
4. Hospital-grade straight-blade receptacles.
5. Receptacles with arc-fault and ground-fault protective devices.
6. Locking receptacles.
7. Pin-and-sleeve receptacles.
8. Special-purpose power outlet assemblies.
9. Connectors, cords, and plugs.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for occupancy sensors, timers, control-voltage switches, and control-voltage dimmers.

1.2 ALLOWANCES

A. See Section 012100 "Allowances" for description of allowances affecting items specified in this Section.

1.3 UNIT PRICES

A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.4 ALTERNATES

A. See Section 012300 "Alternates" for description of alternates affecting items specified in this Section.

1.5 DEFINITIONS

A. Commercial/Industrial-Use Cord Reel: A cord reel subject to severe use in factories, commercial garages, construction sites, and similar locations requiring a harder service-type cord.

B. UL 1472 Type I Dimmer: Dimmer in which air-gap switch is used to energize preset lighting levels.

1.6 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrant(s) for field tests and inspections. Notify Architect**,** and Owner's Commissioning Authority of scheduled meeting dates.

1.7 ACTION SUBMITTALS

A. Product Data:

1. Toggle switches.

2. Key lock switches.

3. Maintained-contact switches.

4. Momentary-contact switches.

5. Rocker switches.

6. Dimmer switches.

7. Fan-speed controllers.

8. Single straight-blade receptacles

9. Duplex straight-blade receptacles.

10. Duplex straight-blade receptacles with integral switching means.

11. Receptacles with AFCI and GFCI devices.

12. Locking receptacles.

13. Pin-and-sleeve receptacles.

14. Cord connectors.

B. Shop Drawings:

1. Wiring diagrams for duplex straight-blade receptacles with integral switching means.

C. Samples:

1. One for each kind of toggle switch and cover plate accessory specified, in each finish and color specified.

2. One for each kind of key lock switch and cover plate accessory specified, in each finish and color specified.

3. One for each kind of maintained-contact switch and cover plate accessory specified, in each finish and color specified.

4. One for each kind of momentary-contact switch and cover plate accessory specified, in each finish and color specified.

5. One for each kind of rocker switch and cover plate accessory specified, in each finish and color specified.

6. One for each kind of dimmer switch and cover plate accessory specified, in each finish and color specified.

7. One for each kind of fan-speed controller switch and cover plate accessory specified, in each finish and color specified.

8. One for each kind of single straight-blade receptacle and cover plate accessory specified, in each finish and color specified.

9. One for each kind of duplex straight-blade receptacle and cover plate accessory specified, in each finish and color specified.

10. One for each kind of duplex straight-blade receptacle with integral switching means and cover plate accessory specified, in each finish and color specified.

11. One for each kind of receptacle with AFCI and GFCI devices and cover plate accessory specified, in each finish and color specified.

12. One for each kind of locking receptacle and cover plate accessory specified, in each finish and color specified.

13. One for each kind of pin-and-sleeve receptacle specified, in each finish and color specified.

14. One for each kind of cord connector specified, in each finish and color specified.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

1.8 INFORMATIONAL SUBMITTALS

A. Manufacturers' Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Dimmers.

2. Fan-speed controllers.

3. Single straight-blade receptacles.

4. Duplex straight-blade receptacles.

5. Duplex straight-blade receptacles with integral switching means.

6. Receptacles with AFCI and GFCI devices.

7. Locking receptacles.

8. Pin-and-sleeve receptacles.

9. Spring-driven commercial/industrial-use cord reels.

B. Sample warranties.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Items: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Extra Keys for Key Lock Switches: One of each kind.

2. SPD Receptacles: Equal to 10 percent of quantity installed for each kind specified, but no fewer than two units.

3. Controlled Receptacles: Equal to 10 percent of quantity installed for each kind specified, but no fewer than two units.

4. Cord Connectors: One of each kind.

B. Special Tools:

1. Proprietary equipment and software required to maintain, repair, adjust, or implement future changes to controlled receptacles.

2. Proprietary equipment required to maintain, repair, adjust, or implement future changes to cord connectors.

1.10 WARRANTY FOR DEVICES

A. Special Manufacturer Extended Warranty: Manufacturer warrants that devices perform in accordance with specified requirements and agrees to provide repair or replacement of devices that fail to perform as specified within extended warranty period.

1. Extended Warranty Period: Three years from date of Substantial Completion; full coverage for labor, materials, and equipment.

2. Follow-On Extended Warranty Period: Eight years from date of Substantial Completion; full coverage for materials that failed because of transient voltage surges only, free on board origin and destination, freight prepaid.

1.11 WARRANTY FOR CORD REELS

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed cord-reel power outlet assemblies perform in accordance with specified requirements and agrees to repair or replace assemblies that fail to perform as specified within extended warranty period.

1. Extended Warranty Period: Three years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that components of cord-reel power outlet assemblies perform in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended warranty period.

1. Extended Warranty Period: Three years from date of Substantial Completion; full coverage for labor, materials, and equipment.

2. Follow-On Extended Warranty Period: Eight years from date of Substantial Completion; full coverage for materials that failed because of transient voltage surges only, free on board origin and destination, freight prepaid.

PART 2 - PRODUCTS

2.1 GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

A. Toggle Switch:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

b. Leviton Manufacturing Co., Inc.

c. Pass & Seymour; Legrand North America, LLC.

d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. General Characteristics:

a. Reference Standards: UL CCN WMUZ and UL 20.

4. Options:

a. Device Color: White in accordance with NEMA WD 1 or as indicated on Architectural Drawings.

b. Configuration:

1) General-duty, 120-277 V, 15 A, single pole, double pole, three way, four way.

2) General-duty, 120-277 V, 20 A, single pole, double pole, three way, four way.

3) Extra-heavy-duty, 120-277 V, 15 A, single pole, double pole, three way, four way.

4) Extra-heavy-duty, 120-277 V, 20 A, single pole, double pole, three way, four way.

5) Extra-heavy-duty, 120-277 V, 30 A, single pole, double pole, three way, four way.

6) Retain "Accessories" Subparagraph below only if this cover plate must exactly match color of this wiring device. Use Section 260533 "Raceway and Boxes for Electrical Systems" to specify common covers or cover plates with matching colors or finishes for use with multiple wiring devices.

5. Accessories:

a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.

b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Toggle Switch with Forked Key Lock:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

b. Leviton Manufacturing Co., Inc.

c. Pass & Seymour; Legrand North America, LLC.

d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

Regulatory Requirements:

e. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. General Characteristics:

a. Reference Standards: UL CCN WMUZ and UL 20.

3. Options:

a. Device Color: White or as indicated on architectural Drawings.

b. Configuration:

1) 120-277 V, 15 A, single pole, double pole, three way, four way.

2) 120-277 V, 20 A, single pole, double pole, three way, four way.

3) 120-277 V, 30 A, single pole, double pole.

C. Type I Dimmer Switch:

1. Unless otherwise noted on plans Dimmer switches will be part of Section 26 0923 “Digital Occupancy and Daylight Management Control System”. If called out separately the information below will be followed for Dimmer switches.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

b. GE Lighting; General Electric Company.

c. Leviton Manufacturing Co., Inc.

d. Lutron Electronics Co., Inc.

e. Pass & Seymour; Legrand North America, LLC.

f. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

3. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

4. General Characteristics:

a. Reference Standards: UL CCN EOYX and UL 1472 Type I dimmer.

5. Options:

a. Device Color: White or as indicated on architectural Drawings.

b. Switch Style: Toggle, Push button.

c. Dimming Control Style: Slide.

6. Accessories:

a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.

b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. Air-Gap Fan-Speed Controller Switch:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

b. Leviton Manufacturing Co., Inc.

c. Pass & Seymour; Legrand North America, LLC.

d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. General Characteristics:

a. Reference Standards: UL CCN GQHG and UL 1917.

4. Options:

a. Device Color: White or as indicated on architectural Drawings.

5. Accessories:

a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.

b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.2 GENERAL-GRADE SINGLE STRAIGHT-BLADE RECEPTACLES

A. Single Straight-Blade Receptacle:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

b. Leviton Manufacturing Co., Inc.

c. Pass & Seymour; Legrand North America, LLC.

d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. General Characteristics:

a. Reference Standards: UL CCN RTRT and UL 498.

4. Options:

a. Device Color: White or as indicated on architectural Drawings].

b. Configuration:

1) General-duty, NEMA 5-15R, NEMA 5-20R, NEMA 5-30R, NEMA 5-50R.

2) General-duty, smooth face, NEMA 5-15R, NEMA 5-20R.

3) General-duty, NEMA 6-15R, NEMA 6-20R, NEMA 6-30R, NEMA 6-50R.

4) General-duty, smooth face, NEMA 6-20R.

5) General-duty, NEMA 14-30R (Dryer), NEMA 14-50R (Range).

6) Heavy-duty, NEMA 5-30R, NEMA 5-50R.

7) Heavy-duty, NEMA 6-30R, NEMA 6-50R.

8) Heavy-duty, NEMA 7-20R, NEMA 7-30R, NEMA 7-50R.

9) Heavy-duty, NEMA 14-20R, NEMA 14-30R (Dryer), NEMA 14-50R (Range), NEMA 14-60R.

10) Heavy-duty, NEMA 15-20R, NEMA 15-30R, NEMA 15-50R, NEMA 15-60R.

11) Heavy-duty, NEMA 18-20R, NEMA 18-30R, NEMA 18-50R, NEMA 18-60R

12) Extra-heavy-duty, NEMA 5-15R, NEMA 5-20R.

13) Extra-heavy-duty, NEMA 6-15R, NEMA 6-20R.

5. Accessories:

a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.

b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Tamper-Resistant, Clock Hanger Straight-Blade Receptacle:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Pass & Seymour; Legrand North America, LLC.

b. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. General Characteristics:

a. Reference Standards: UL CCN RTRT and UL 498.

4. Options:

a. Finish: White nylon.

b. Configuration: Recessed, smooth wallplate; NEMA 5-15R, NEMA 5-20R.

C. Tamper-Resistant, Floor-Mounted Display Straight-Blade Receptacle:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Pass & Seymour; Legrand North America, LLC.

b. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. General Characteristics:

a. Reference Standards: UL CCN RTRT and UL 498.

b. Configuration: NEMA 5-15R.

4. Options:

a. Finish: Nickel plated.

D. spring mechanisms and moving parts of cord reels and fittings to function smoothly, and lubricate as recommended in writing by manufacturer.

2.3 GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES

A. Duplex Straight-Blade Receptacle:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

b. Leviton Manufacturing Co., Inc.

c. Pass & Seymour; Legrand North America, LLC.

d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. General Characteristics:

a. Reference Standards: UL CCN RTRT and UL 498.

4. Options:

    a. Device Color: White in accordance with NEMA WD 1, or as indicated on Architectural Drawings.

    b. Configuration:

        1) General-duty, NEMA 5-20R.

        2) General-duty, smooth face, NEMA 5-20R.

        3) General-duty NEMA 6-20R.

        4) General-duty, smooth face, NEMA 6-20R.

        5) Heavy-duty, NEMA 5-20R.

        6) Heavy-duty, smooth face, NEMA 5-20R.

        7) Heavy-duty, NEMA 6-20R.

5. Accessories:

    a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.

    b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Tamper-Resistant Duplex Straight-Blade Receptacle:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

    b. Leviton Manufacturing Co., Inc.

    c. Pass & Seymour; Legrand North America, LLC.

    d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Regulatory Requirements:

    a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. General Characteristics:

    a. Reference Standards: UL CCN RTRT and UL 498.

4. Options:

a. Device Color: White in accordance with NEMA WD 1 or as indicated on Drawings.

b. Configuration:

1) General-duty, NEMA 5-20R.

2) General-duty, smooth face, NEMA 5-20R.

3) Heavy-duty, NEMA 5-20R.

4) Heavy-duty, smooth face, NEMA 5-20R.

5) Extra-heavy-duty, NEMA 5-20R.

5. Accessories:

a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.

b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

C. Tamper-Resistant Duplex Straight-Blade Receptacle with USB Outlet to Power Class 2 Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

b. Leviton Manufacturing Co., Inc.

c. Pass & Seymour; Legrand North America, LLC.

d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. General Characteristics:

a. Reference Standards: UL CCN RTRT and UL 498.

4. Options:

a. Device Color: White or as indicated on Architectural Drawings.

b. Configuration:

1) General-duty, NEMA 5-20R; two USB-A ports.

2) General-duty, NEMA 5-20R; two USB-C ports.

3) General-duty, NEMA 5-20R; one USB-A port; one USB-C port.

4) General-duty, smooth face, two USB-A ports.

5) General-duty, smooth face, four USB-A ports.

5. Accessories:

a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.

b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. Wired Full-Controlled Duplex Straight-Blade Receptacle:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hubbell Incorporated, Lighting.

b. Pass & Seymour; Legrand North America, LLC.

c. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. General Characteristics:

a. Reference Standards: UL CCN RTXI and UL Subject 498B.

4. Options:

a. Device Color: White or as indicated on Architectural Drawings.

b. Configuration: NEMA 5-20R.

5. Accessories:

a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.

b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

E. Wired Half-Controlled Duplex Straight-Blade Receptacle:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Hubbell Incorporated, Lighting.

    b. Pass & Seymour; Legrand North America, LLC.

    c. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Regulatory Requirements:

    a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. General Characteristics:

    a. Reference Standards: UL CCN RTXI and UL Subject 498B.

4. Options:

    a. Device Color: White or as indicated on Architectural Drawings.

    b. Configuration: NEMA 5-20R.

5. Accessories:

    a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.

    b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.4 RECEPTACLES WITH ARC-FAULT AND GROUND-FAULT PROTECTIVE DEVICES

A. General-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with AFCI Device:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

    b. Leviton Manufacturing Co., Inc.

    c. Pass & Seymour; Legrand North America, LLC.

    d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. General Characteristics:

a. Reference Standards: UL CCN AWBZ, UL 498, UL 1699, and UL Subject 1699A.

4. Options:

a. Device Color: White or as indicated on Architectural Drawings.

b. Configuration: Heavy-duty, NEMA 5-20R.

5. Accessories:

a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.

b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. General-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with AFCI and GFCI Device:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

b. Leviton Manufacturing Co., Inc.

c. Pass & Seymour; Legrand North America, LLC.

d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. General Characteristics:

a. Reference Standards: UL CCN KCXX, UL 498, UL 943, UL 1699, and UL Subject 1699A.

4. Options:

a. Device Color: White or as indicated on Architectural Drawings.

b. Configuration: Heavy-duty, NEMA 5-20R.

5. Accessories:

    a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.

    b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

C. General-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

    b. Leviton Manufacturing Co., Inc.

    c. Pass & Seymour; Legrand North America, LLC.

    d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Regulatory Requirements:

    a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. General Characteristics:

    a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.

4. Options:

    a. Device Color: White or as indicated on Architectural Drawings.

    b. Configuration: Heavy-duty, NEMA 5-20R.

5. Accessories:

    a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.

    b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. General-Grade, Weather-Resistant, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

    b. Leviton Manufacturing Co., Inc.

c. Pass & Seymour; Legrand North America, LLC.

d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. General Characteristics:

a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.

4. Options:

a. Device Color: White or as indicated on Architectural Drawings.

b. Configuration: Heavy-duty, NEMA 5-20R.

5. Accessories:

a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.

b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.5 LOCKING RECEPTACLES

A. NEMA, 125 V, Locking Receptacle: Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

b. Leviton Manufacturing Co., Inc.

c. Pass & Seymour; Legrand North America, LLC.

d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. General Characteristics:

a. Reference Standards: UL CCN RTRT and UL 498.

4. Options:

a. Device Color: Black with yellow voltage indication on face.

b. Configuration: 2 pole, 3 wire, grounding, NEMA L5-20R, NEMA L5-30R.

B. NEMA, 250 V, Locking Receptacle:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

b. Leviton Manufacturing Co., Inc.

c. Pass & Seymour; Legrand North America, LLC.

d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. General Characteristics:

a. Reference Standards: UL CCN RTRT and UL 498.

4. Options:

a. Device Color: Black with blue voltage indication on face.

b. Configuration:

1) 2 pole, 3 wire, grounding, NEMA L6-20R, NEMA L6-30R.

2) 3 pole, 4 wire, grounding, NEMA L15-20R, NEMA L15-30R.

3) 4 pole, 4 wire, non-grounding, NEMA L18-20R, NEMA L18-30R.

4) 4 pole, 5 wire, grounding, NEMA L21-20R, NEMA L21-30R.

2.6 PIN-AND-SLEEVE RECEPTACLES

A. C2 Series, 125/250 V, Pin-and-Sleeve Receptacles:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Products Division.

b. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

c. Crouse-Hinds; Eaton, Electrical Sector.

d. Killark; Hubbell Incorporated, Construction and Energy.

e. Leviton Manufacturing Co., Inc.

f. Pass & Seymour; Legrand North America, LLC.

g. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. General Characteristics:

a. Reference Standards: UL CCN QLIW, UL 1682, and UL 1686.

b. Series: UL 1686 C2 and IEC 60309-2 Series II.

c. Voltage Rating: 125/250 V.

4. Options:

a. Configuration:

1) 2 pole, 3 wire, 20 A, 30 A, IP67, 30 A, IP69k, 60 A, IP67, 60 A, IP69k, 100 A.

2) 3 pole, 4 wire, 20 A, 30 A, IP67, 30 A, IP69k, 60 A, IP67, 60 A, IP69k, 100 A, IP67, 100 A, IP69k.

3) 4 pole, 5 wire, 20 A, 30 A, IP67, 30 A, IP69k, 60 A, IP67, 60 A, IP69k, 100 A, IP67, 100 A, IP69k.

B. C2 Series, 480 V, Pin-and-Sleeve Receptacles:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Products Division.

b. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

c. Crouse-Hinds; Eaton, Electrical Sector.

d. Killark; Hubbell Incorporated, Construction and Energy.

e. Leviton Manufacturing Co., Inc.

f. Pass & Seymour; Legrand North America, LLC.

g. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. General Characteristics:

a. Reference Standards: UL CCN QLIW, UL 1682, and UL 1686.

b. Series: UL 1686 C2 and IEC 60309-2 Series II.

c. Voltage Rating: 480 V.

4. Options:

a. Configuration:

1) 2 pole, 3 wire, 20 A, 30 A, IP67, 30 A, IP69k, 60 A, IP67, 60 A, IP69k, 100 A.

2) 3 pole, 4 wire, 20 A, 30 A, IP67, 30 A, IP69k, 60 A, IP67, 60 A, IP69k, 100 A, IP67, 100 A, IP69k.

3) 4 pole, 5 wire, 20 A, 30 A, IP67, 30 A, IP69k, 60 A, IP67, 60 A, IP69k, 100 A, IP67, 100 A, IP69k.

2.7 CONNECTORS, CORDS, AND PLUGS

A. Outdoor-Use, Watertight, Sealed Cord Connector:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Ericson Manufacturing Company.

2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. General Characteristics:

a. Reference Standards: UL CCN AXUT and UL 498.

4. Options:

a. Configuration:

1) NEMA 6-20.

2) NEMA L5-20 with diagnostic LED indicator.

3) NEMA L5-30.

4) NEMA L6-20.

5) NEMA L6-30.

6) NEMA L7-20.

7) NEMA L7-30.

8) NEMA L14-20.

9) NEMA L14-30.

10) NEMA L15-20.

11) NEMA L15-30.

12) NEMA L16-20.

13) NEMA L16-30.

14) NEMA L17-30.

15) NEMA L18-30.

2.8 FINISHES

A. Device Color:

Finishes: Manufacturer offers a minimum of 6 finish and trim combinations, including painted and satin anodized aluminum finishes and wood grain type trim. Furnish with final finish as selected from samples.

1. Wiring Devices Connected to Normal Power System: White or as indicated on Architectural Drawings unless otherwise indicated or required by NFPA 70 or device listing.

2. Wiring Devices Connected to Emergency Power System: Red.

3. TVSS Devices: Blue.

B. Wall Plate Color: For plastic covers, match device color.

2.9 MANUAL SWITCHES AND PLATES

A. Locator Light: Internal illumination helps locate switch in the dark. Use where indicated.

B. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receptacles:

1. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

3.2 INSTALLATION OF SWITCHES

A. Comply with manufacturer's instructions.

B. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.

2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.

3. Consult Architect for resolution of conflicting requirements.

C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."

a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.

3.3 INSTALLATION OF STRAIGHT-BLADE RECEPTACLES

A. Comply with manufacturer's instructions.

B. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.

2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.

3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.

    a. Receptacle Orientation: Orient receptacle with ground pin or neutral pin at top.

4. Consult Architect for resolution of conflicting requirements.

C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."

    a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black filled lettering, and provide durable wire markers or tags inside device box or outlet box.

D. Interfaces with Other Work:

1. Do not install Type 3 SPD, including surge-protected relocatable taps and power strips, on branch circuit downstream of GFCI device.

2. Coordinate installation of new products for with existing conditions.

3.4 INSTALLATION OF LOCKING RECEPTACLES

A. Comply with manufacturer's instructions.

B. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.

2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.

3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.

4. Consult Architect for resolution of conflicting requirements.

C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."

    a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.

D. Interfaces with Other Work:

1. Coordinate with all other trades in this project and systems.

3.5 INSTALLATION OF PIN-AND-SLEEVE RECEPTACLES

A. Comply with manufacturer's instructions.

B. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.

2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.

3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in UL 1686.

4. Consult Architect for resolution of conflicting requirements.

C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."

a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.

D. Interfaces with Other Work:

1. Coordinate with all other trades in this project and systems

3.6 INSTALLATION OF CORD REELS AND FITTINGS

A. Comply with manufacturer's instructions.

3.7 INSTALLATION OF CONNECTORS, CORDS, AND PLUGS

A. Comply with manufacturer's instructions.

3.8 FIELD QUALITY CONTROL OF SWITCHES

A. Field tests and inspections must be witnessed by Architect.

B. Tests and Inspections:

1. Perform tests and inspections in accordance with manufacturers' instructions.

2. See Section 014000 "Quality Requirements" for retesting and re-inspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

3. Check TVSS receptacle indicating lights for normal indication

4. Test ground-fault circuit interrupter operation with both local and remote fault simulations according to manufacturer recommendations.

5. Unit will be considered defective if it does not pass tests and inspections.

6. Remove and replace defective units and retest.

C. Assemble and submit test and inspection reports.

D. Manufacturer Services:

1. Engage factory-authorized service representative to supervise field tests and inspections.

3.9 FIELD QUALITY CONTROL OF STRAIGHT-BLADE RECEPTACLES

A. Field tests and inspections must be witnessed by Architect.

B. Tests and Inspections

1. Insert and remove test plug to verify that device is securely mounted.

2. Verify polarity of hot and neutral pins.

3. Measure line voltage.

4. Measure percent voltage drop.

5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.

6. Healthcare Facilities: Test straight-blade receptacles in patient care spaces with receptacle pin tension test instrument in accordance with NFPA 99. Retention force of ground pin must be not less than 115 g (4 oz).

7. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.

C. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.

2. Remove and replace defective units and retest.

D. Assemble and submit test and inspection reports.

E. Manufacturer Services:

1. Engage factory-authorized service representative to supervise field tests and inspections.

3.10 IELD QUALITY CONTROL OF LOCKING RECEPTACLES

A. Field tests and inspections must be witnessed by Architect.

B. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.

2. Verify polarity of hot and neutral pins.

3. Measure line voltage.

4. Measure percent voltage drop.

5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.

6. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.

C. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.

2. Remove and replace defective units and retest.

D. Assemble and submit test and inspection reports.

E. Manufacturer Services:

1. Engage factory-authorized service representative to supervise field tests and inspections.

3.11 FIELD QUALITY CONTROL OF PIN-AND-SLEEVE RECEPTACLES

A. Field tests and inspections must be witnessed by Architect.

B. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.

2. Measure line voltage.

3. Measure percent voltage drop.

4. Measure ground impedance, which must be not greater than 2 ohms.

5. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.

C. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.

2. Remove and replace defective units and retest.

D. Assemble and submit test and inspection reports.

E. Manufacturer Services:

1. Engage factory-authorized service representative to supervise field tests and inspections.

3.12 FIELD QUALITY CONTROL OF CORD REELS AND FITTINGS

A. Field tests and inspections must be witnessed by Architect.

B. Tests and Inspections:

1. Perform tests and inspections indicated in manufacturer's instructions.

C. Nonconforming Work:

1. Components and assemblies will be considered defective if they do not pass tests and inspections.

2. Remove and replace defective units and retest.

D. Assemble and submit test and inspection reports.

E. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

3.13 FIELD QUALITY CONTROL OF CONNECTORS, CORDS, AND PLUGS

A. Field tests and inspections must be witnessed by Architect.

B. Tests and Inspections:

1. Perform tests and inspections indicated in manufacturer's instructions.

C. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.

2. Remove and replace defective units and retest.

D. Assemble and submit test and inspection reports.

E. Manufacturer Services:

1. Engage factory-authorized service representative to supervise field tests and inspections.

3.14 SYSTEM STARTUP FOR SWITCHES

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks for momentary switches, dimmer switches, and fan-speed controller switches in accordance with manufacturer's instructions.

3.15 ADJUSTING

A. Occupancy Adjustments for Controlled Receptacles: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

B. Cord Reels and Fittings: Adjust spring mechanisms and moving parts of cord reels and fittings to function smoothly, and lubricate as recommended in writing by manufacturer.

3.16 PROTECTION

A. Devices:

1. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.

2. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

B. Cord Reels and Fittings:

1. After installation, protect cord reels and fittings from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

C. Connectors, Cords, and Plugs:

1. After installation, protect connectors, cords, and plugs from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.17 CLEANING

A. General: Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices. Replace wall plates or devices marked with pencil, pen, or other non-standard marking system. Thoroughly clean all device plates, remove fingerprints, smudges, and dirt.

B. Dimmer Switches:

1. Wattage rating exceeds connected load by 30 percent minimum, except as otherwise indicated.

END OF SECTION 26 2726

SECTION 26 2813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:

a. Control circuits.

b. Motor-control centers.

c. Panelboards.

d. Switchboards.

e. Enclosed controllers.

f. Enclosed switches.

2. Spare-fuse cabinets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.

b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.

3. Current-limitation curves for fuses with current-limiting characteristics.

4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in electronic format suitable for use in coordination software and in PDF format.

5. Coordination charts and tables and related data.

6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017700 "Closeout Procedures," and Section 017823 "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.

2. Current-limitation curves for fuses with current-limiting characteristics.

3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in electronic format suitable for use in coordination software and in PDF format.

4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg. F temperature or more than 100 deg. F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton (Bussmann & Edison).

2. Littelfuse, Inc.

3. Mersen USA.

B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

1. Type RK-1: 250, 600-V, zero- to 600-A rating, 200 kAIC, time delay.

2. Type RK-5: 250, 600-V, zero- to 600-A rating, 200 kAIC, time delay.

3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting.

4. Type CD: 600-V, 31- to 60-A rating, 200 kAIC, fast acting.

5. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.

6. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.

7. Type T: 250-V, zero- to 1200-A, 600-V, zero- to 800-A rating, 200 kAIC, very fast acting.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.

2. Finish: Gray, baked enamel.

3. Identification: "SPARE FUSES" in 1-1/2-inch-high letters on exterior of door.

4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Fluorescent and H.I.D. Ballasts: over 300 volts, Class CC or Class J, time delay.

B. DC Circuits: Less than 500 volts, 0-600 Class J, time delay; 601-6000A Class L, time delay.

C. Existing Installations as above, or RK1 time delay

D. Cartridge Fuses:

1. Service Entrance: Class L, fast acting, Class RK1, fast acting, Class J, fast acting, Class T, fast acting.

2. Feeders: Class L, fast acting, Class RK1, fast acting, Class RK5, fast acting, lass J, fast acting.

3. Motor Branch Circuits: Class RK1, Class RK5, Class CC, motor duty, time delay.

4. Large Motor Branch (601-4000 A): Class L, time delay.

5. Power Electronics Circuits: Class J, high speed, Class T, fast acting.

6. Other Branch Circuits: Class RK1, time delay, Class RK5, time delay, Class J, fast acting, Class J, time delay, Class CC, fast acting.

7. Control Transformer Circuits: Class CC, time delay, control transformer duty.

8. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Architect, Owner.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 2813

SECTION 26 2816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.

2. Nonfusible switches.

3. Receptacle switches.

4. Shunt trip switches.

5. Molded-case circuit breakers (MCCBs).

6. Molded-case switches.

7. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.

2. Current and voltage ratings.

3. Short-circuit current ratings (interrupting and withstand, as appropriate).

4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.

5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF and electronic format.

B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.

2. Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Data: Certificates, for enclosed switches and circuit breakers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of

overcurrent protective device. Provide in [PDF] [and] <Insert calculation program format> electronic format.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

2. Fuse Pullers: Two for each size and type.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.

2. Altitude: Not exceeding 6600 feet.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with NFPA 70.

2.3 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB (Electrification Products Division).

2. Eaton.

3. Schneider Electric USA (Square D).

4. Siemens Industry, Inc., Energy Management Division.

B. Type HD, Heavy Duty:

1. Single, Double, throw.

2. Three, six pole.

3. 250, 600-V ac.

4. 1200 A and smaller , 200 A and smaller.

5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified and or indicated fuses.

6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.

4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

5. Auxiliary Contact Kit: [One] [Two] NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 24-V ac, 120-V.

6. Hookstick Handle: Allows use of a hookstick to operate the handle.

7. Lugs: Compression type, suitable for number, size, and conductor material.

8. Service-Rated Switches: Labeled for use as service equipment.

2.4 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB (Electrification Products Division).

2. Eaton.

3. Schneider Electric USA (Square D).

4. Siemens Industry, Inc., Energy Management Division.

A. Type GD, General Duty, Three Pole, Single Throw, 240-V ac, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

B. Type HD, Heavy Duty, Three Pole, Single Throw, 250, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Six Pole, Single Throw, 250, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Three Pole, Double Throw, 250, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.

4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

5. See "Control Power Options" Article in the Evaluations for various sources available for control power. Although other voltages are available, the Section Text includes only those that are most frequently encountered and listed in manufacturers' literature. Integrally mounted control power is not available in safety switches.

6. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 24-V ac, 120-V ac.

7. Hookstick Handle: Allows use of a hookstick to operate the handle.

8. Lugs: Compression type, suitable for number, size, and conductor material.

9. Service-Rated Switches: Labeled for use as service equipment.

2.5 RECEPTACLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB, Electrification Products Division.

2. Eaton.

3. Siemens Industry, Inc., Energy Management Division.

4. Square D; Schneider Electric USA.

B. Listed manufacturers offer similar but different options for voltage and ampere ratings and the make and model of receptacles available for factory installation on their switches. See the "Receptacle Switches" Article in the Evaluations. Not all listed voltage and ampere ratings and enclosure types listed in "Enclosures" Article are available from all listed manufacturers.

C. Show pole quantities and voltage and ampere ratings of switches on Drawings. Retain one of last two options in first paragraph below depending on whether fuse applications and class designations are indicated on Drawings or specified in Section 262813 "Fuses." Show fuse ampere ratings on Drawings.

D. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: 250, 600-V ac, 30, 60, 100A; UL 98 and NEMA KS 1; horsepower rated, with clips or bolt pads to accommodate specified and or indicated fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

E. Type HD, Heavy-Duty, Three Pole, Single-Throw Non-fusible Switch: 250, 600-V ac, 30, 60, 100A; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

F. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.

G. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).

H. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.

4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

5. See "Control Power Options" Article in the Evaluations for various sources available for control power. Although other voltages are available, the Section Text includes only those that are most frequently encountered and listed in manufacturers' literature. Integrally mounted control power is not available in safety switches.

6. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 24-V ac, 120-V ac.

7. Hookstick Handle: Allows use of a hookstick to operate the handle.

8. Lugs: Compression type, suitable for number, size, and conductor material.

9. Service-Rated Switches: Labeled for use as service equipment.

2.6 SHUNT TRIP SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton (Bussmann & Edison).

2. Littelfuse, Inc.

3. Mersen USA.

A. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with Class J fuse block and 200-kA interrupting and short-circuit current rating.

B. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: 250, 600-V ac, 30, 60, 100A; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, with clips or bolt

pads to accommodate specified and or indicated fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

C. Type HD, Heavy-Duty, Three Pole, Single-Throw Nonfusible Switch: 250, 600-V ac, 30, 60, 100A; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; obtained from [integral control power transformer, with primary and secondary fuses, with a control power transformer of enough capacity to operate shunt trip, pilot, indicating and control devices.

E. Accessories:

1. Oiltight key switch for key-to-test function.

2. Oiltight green ON pilot light.

3. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.

4. Form C alarm contacts that change state when switch is tripped.

5. Three-pole, double-throw, fire-safety and alarm relay; 120-V ac, 24-V dc, coil voltage.

6. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

7. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

8. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.

9. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

10. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 24-V ac, 120-V ac.

11. Hookstick Handle: Allows use of a hookstick to operate the handle.

12. Lugs: Compression type, suitable for number, size, and conductor material.

13. Service-Rated Switches: Labeled for use as service equipment.

2.7 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB (Electrification Products Division).

2. Eaton.

3. NOARK Electric North America.

4. Schneider Electric USA (Square D).

5. Siemens Industry, Inc., Energy Management Division.

6. General Switch Corporation

B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated or series rated as indicated on the Drawings. Circuit breaker/circuit breaker or Fuse/circuit breaker combinations for series connected interrupting ratings shall be listed by UL as recognized component combinations. Any series rated combination used shall be marked on the end-use equipment along with the statement.

E. MCCBs shall be equipped with a device for locking in the isolated position.

F. Lugs shall be suitable for 167 deg F rated wire on 125-A circuit breakers and below, sized according to the 167 deg F temperature rating in NFPA 70.

G. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.

H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.

2. Long- and short-time pickup levels.

3. Long- and short-time time adjustments.

4. Ground-fault pickup level, time delay, and I-squared t response.

K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

L. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

M. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

N. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

O. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.

2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.

3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.

4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

5. Communication Capability: Universal-mounted communication module with functions and features compatible with power monitoring and control system.

6. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

8. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

9. Alarm Switch: One NO and NC contact that operates only when circuit breaker has tripped.

10. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

11. Zone-Selective Interlocking: Integral with electronic and ground-fault trip unit; for interlocking ground-fault protection function.

12. Electrical Operator: Provide remote control for on, off, and reset operations.

13. Accessory Control Power Voltage: [Integrally mounted, self-powered] [Remote mounted and powered]; [24-V ac] [120-V ac] [208-V ac] [240-V ac] [12-V dc] [24-V dc] [120-

V dc Accessory Control Power Voltage: Integrally mounted, self-powered; 24-V ac, 120-V ac.

2.8 MOLDED-CASE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB (Electrification Products Division).
2. Eaton.
3. NOARK Electric North America.
4. Schneider Electric USA (Square D).
5. Siemens Industry, Inc., Energy Management Division.
6. Westinghouse Electric Corp.; Distribution & Control Business Unit

B. Description: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.

D. Features and Accessories:

1. Standard frame sizes and number of poles.
2. Lugs:
    a. Compression type, suitable for number, size, trip ratings, and conductor material.
    b. Lugs shall be suitable for 140 deg F rated wire on 125-A circuit breakers and below 167 deg F rated wire, sized according to the 167 deg F temperature rating in NFPA 70.
3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Under voltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

6. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.

7. Alarm Switch: One NO and NC contact that operates only when switch has tripped.

8. Key Interlock Kit: Externally mounted to prohibit switch operation; key shall be removable only when switch is in off position.

9. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.

10. Electrical Operator: Provide remote control for on, off, and reset operations.

11. Accessory Control Power Voltage: Integrally mounted, self-powered and powered; 24-V ac, 120-V ac.

2.9 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Enclosed, Molded-Case Circuit Breaker: with lockable handle.

2. Application Listing: Appropriate for application, including heating, air-conditioning, and refrigerating equipment.

3. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.

4. Circuit Breakers, 400 A and Larger: Field-adjustable, short-time and continuous current settings.

5. Indoor, Dry and Clean Locations: NEMA 250, [Type 1] <Insert type>.

6. Outdoor Locations: NEMA 250, [Type 3R] <Insert type>.

7. [Kitchen] [Wash-Down] Areas: NEMA 250, [Type 4X] <Insert type>, [stainless steel] <Insert material>.

8. Other Wet or Damp, Indoor Locations: NEMA 250, [Type 4] <Insert type>.

9. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

1. Hazardous Areas Indicated on Drawings: NEMA 250, [Type 7] [Type 9] <Insert type Indoor, Dry and Clean Locations: NEMA 250, Type 1.

2. Outdoor Locations: NEMA 250, Type 3R.

3. Kitchen, Wash-Down Areas: NEMA 250, Type 4X.

4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.

5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7.

B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1), gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (NEMA 250 Types 3R, 12), a brush finish on Type 304 stainless steel (NEMA 250 Type 4-4X stainless steel), copper-free cast aluminum alloy (NEMA 250 Types 7, 9).

C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.

D. Operating Mechanism: The circuit-breaker operating handle shall be [externally operable with the operating mechanism being an integral part of the box, not the cover] [directly operable through the front cover of the enclosure (NEMA 250 Type 1)] [directly operable through the dead front trim of the enclosure (NEMA 250 Type 3R)] [externally operable with the operating mechanism being an integral part of the cover (NEMA 250 Types 7, 9)]. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 PREPARATION

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect, Owner no fewer than seven days in advance of proposed interruption of electric service.

2. Indicate method of providing temporary electric service.

3. Do not proceed with interruption of electric service without Architect's, Owner's written permission.

4. Comply with NFPA 70E.

3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.

2. Outdoor Locations: NEMA 250, Type 3R.

3. Kitchen, Wash-Down Areas: NEMA 250, Type 4X.

4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.

5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

3.4 INSTALLATION

A. Install disconnect switches and circuit breakers in locations as indicated, according to manufacturer's written instructions.

B. Install disconnect switches and circuit breakers level and plumb.

C. Install wiring between disconnect switches, circuit breakers, control, and indication devises.

D. Connect disconnect switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

E. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

F. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

G. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

H. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

I. Install fuses in fusible devices.

J. Comply with NFPA 70 and NECA 1.

3.5 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections[with the assistance of a factory-authorized service representative].

E. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.

b. Inspect anchorage, alignment, grounding, and clearances.

c. Verify that the unit is clean.

d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.

e. Verify that fuse sizes and types match the Specifications and Drawings.

f. Verify that each fuse has adequate mechanical support and contact integrity.

g. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter.

a) 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.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.

i. Verify correct phase barrier installation.

j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

c. 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 in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.

e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

F. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:

a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.

b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, grounding, and clearances.

d. Verify that the unit is clean.

e. Operate the circuit breaker to ensure smooth operation.

f. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter.

a) 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.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

g. Inspect operating mechanism, contacts, and chutes in unsealed units.

h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate

values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.

e. Determine the following by primary current injection:

1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.

f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.

g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.

h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.

i. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

4. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.

c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

G. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

H. Prepare test and inspection reports.

1. Test procedures used.

2. Include identification of each enclosed switch and circuit breaker tested and describe test results.

3. List deficiencies detected, remedial action taken, and observations after remedial action.

Consider the following:

3.7 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

3.8 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges[as specified in Section 260573.16 "Coordination Studies."] [to values indicated on the Drawings.] [to values indicated in attached schedule.]

END OF SECTION 26 2816

SECTION 26 4313 – TRANSIENT VOLTAGE SUPPRESSOR FOR LOW VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Requirements of the following Division 26 Sections apply to this Section:

1. "Basic Electrical Materials and Methods."

1.2 SUMMARY

A. Transient voltage surge suppressor (TVSS) for low voltage power equipment.

B. This Section is hereby made a part of all other applicable sections of Division 26 as fully as if repeated in each therein.

1.3 QUALITY ASSURANCE

A. TVSS devices shall be tested to and comply with the latest editions of the following standards:

1. NFPA 70, 75 and 78

2. UL Standard 1449 and 1283

3. IEEE STD 142 and 518

4. ANSI/IEEE C62.41 and C62.45

5. FIPS PUB 94

6. NEMA LS-1

7. ANSI

8. MIL-STD 220A

B. UL Compliance: Comply with UL 1449 and UL 1283.

C. The system shall be tested to MIL-STD 220A for electrical line noise attenuation per 50 ohm insertion loss measurement method of RF frequencies up to 100 MHz.

D. Thoroughly Factory test to UL Manufacturing and production-line tests, quality assurance tests, MCOV tests, and surge clamping voltage verification tests.

E. NEMA Compliance: Comply with NEMA LS-1.

1.4 TESTING

A. Single Pulse Surge Current Capacity

1. In compliance with NEMA LS-1-1992, Paragraphs 2.2.9 and 3.9, the system design configuration shall have the maximum single pulse surge current tested in all modes at rated surge currents by an industry-recognized independent testing laboratory.

2. Single Pulse Surge Current Capacity Test
   a. An initial UL 1449 Second Edition, surge defined as a 1.2 x 50 µsec, 6000V open circuit voltage waveform and an 8 x 20 µsec, 500A short circuit current waveform shall be applied to benchmark TVSS suppression voltage.
   b. A single pulse surge of maximum rated surge current magnitude with an approximated 8 x 20 µsec waveform shall then be applied.
   c. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival.

3. Survival is achieved if the suppression voltage measured from the two UL 1449 surges does not vary by more than 10%.

B. Minimum Repetitive Surge Current Capacity

1. The system design configuration shall have a repetitive surge current capacity rating which shall be verified through testing.

2. Minimum Repetitive Surge Current Capacity Test
   a. An initial UL 1449 Second Edition, surge defined as a 1.2 x 50 µsec, 6000V open circuit voltage waveform and an 8 x 20 µsec, 500A short circuit current waveform shall be applied to benchmark TVSS suppression voltage.
   b. A repetitive number of ANSI/IEEE C62.41-1991 (Category C3) surges defined as a 1.2 x 50 microsecond 20,000V open circuit voltage waveform and an 8 x 20 microsecond 10,000A short current waveform shall then be applied at one minute intervals.
   c. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival.

3. Survival is achieved if the suppression voltage measured from the two UL 1449 surges does not vary by more than 10%.

C. Short Circuit Fuse Testing

1. The system design configuration shall be short circuit tested in accordance with the type of fusing utilized in the suppression path.

2. Short Circuit Fuse Test

a. Testing shall include application of a sustained overvoltage that causes the unit to enter a bolted fault condition.
b. This bolted fault condition shall occur with the full rated AIC current of the fuse available.

3. The fuse shall fail in a safe manner with no physical or structural damage to the unit and any failure shall be self-contained within the unit.

D. Surge Current Fuse Testing

1. The system design configuration shall be surge tested with fusing in series to verify that a transient of maximum surge current capacity magnitude is fully suppressed without fuse failure, operation or degradation.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated, include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

B. Test Documentation: Provide documentation of compliance for testing identified above at the values stated in Section 2.2 below.

1. Copy of the test report documenting compliance with the single pulse surge current capacity requirement specified in Section 2.2.F.

2. Copy of the test report documenting compliance with the minimum repetitive surge capacity requirement specified in Section 2.2.G.

3. Documentation of the system's ability to meet the overvoltage requirements specified in Section 2.2.H.

C. Product Certificates: Signed by manufacturers of transient voltage suppression devices, certifying that products furnished comply with the following testing and labeling requirements.

1. UL 1283 Certification.

2. UL 1449 Listing & Classification.

D. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Failed test results and corrective action taken to achieve requirements.

E. Maintenance Data: For transient voltage suppression devices to include in maintenance manuals specified in Division 1.

F. Warranties: Special warranties specified in this Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Current Technology

2. Liebert, Control Concepts

3. L.E.A. Dynatech

4. United Power

5. Square D (Advanced Protection Technologies)

B. Unit shall be manufactured in the USA by a qualified manufacturer of suppression filter systems equipment.

2.2 TRANSIENT VOLTAGE SURGE SUPPRESSOR (TVSS)

A. Equipment is multi-stage parallel protector rated for operating voltage and phase, plus ground. The equipment surge current capacity, based on an 8 x 20 microsecond waveform per ANSI/IEEE C62.41 Category C3 rating, shall be a minimum of 350,000 Amperes per phase.

B. The system protection modules shall contain a high performance, balanced metal oxide varistor (MOV) array and filtering circuit.

C. Each individual surge protection unit shall be considered on its own merit. Units which rely on other external or upstream units to achieve the required performance and UL 1449 listing are expressly excluded.

D. Maximum Continuous Operating Voltage (MCOV). Maximum continuous operating voltage (MCOV) of all suppression components utilized in the unit shall not be less than 115% of the facility's normal operating voltage.

E. Protection Modes: The TVSS shall provide line-to-neutral (L-N), line-to-ground (L-G), and neutral-to-ground (N-G) protection.

F. Tested Single-Pulse Surge Current Capacity. Based on ANSI/IEEE C62.41 standard 8 x 20 microsecond current waveform, and in accordance with NEMA Publication No. LS-1, the tested single pulse surge current capacity, in amps, of the unit shall be no less than as follows:

Mode of Protection	Tested Single Pulse Surge Current
L-L	200,000
L-N	200,000
L-G	150,000
N-G	100,000

G. Minimum Repetitive Surge Capacity: The system shall be life cycle tested to 13,000 sequential ANSI/IEEE C62.41 Category C3 waveforms (8 x 20 µsec at 10,000 amperes; 1.2 x 50 µsec at 20,000 volts) without failing or degrading the UL 1449 surge suppression rating by more than 10%.

H. The TVSS shall be capable of dissipating large amounts of average power that may be caused by overvoltage events and voltage swells as well as repetitive transient impulses.

1. The TVSS shall be capable of dissipating and surviving the effects of a 200% overvoltage condition for 60 cycles at a power system line impedance of .7 ohms.

2. The TVSS shall be capable of dissipating and surviving the effects of a 200% overvoltage condition for 11 cycles at a power system line impedance of .3 ohms.

I. High Frequency Extended Range Tracking Filter: The unit shall include a high-frequency extended range tracking filter and shall be UL 1283 Listed as an Electromagnetic Interference Filter. The filter shall reduce fast rise-time, high-frequency, error-producing transients and electrical line noise to harmless levels, thus eliminating disturbances which may lead to system upset. The filter shall provide minimum noise attenuation as follows:

Attenuation Frequency	Insertion Loss (ratio)	Insertion Loss (dB)
100 kHz	50-1	34
1 MHz	350-1	51
10 MHz	500-1	54
100 MHz	250-1	48

*Note: Standardized insertion loss data obtained utilizing MIS-STD-E220A 50 ohm insertion loss methodology

J. The unit shall include solid-state, long-life, externally mounted LED visual status indicators that monitor the on-line status of each phase of the unit. Provide two (2) Form-C contacts for remote monitoring when suppressor module is inoperative, and two disturbance counters.

K. Performance Ratings: The system performance ratings shall be based on the UL 1449 listing ratings for IEEE C62.41 Category B equipment. The maximum UL 1449 voltage clamping rating for each of the specified protection modes shall be 800 volts for 480Y/277V systems and 400 volts for 208Y/120V systems.

L. Field Connections: The unit shall include mechanical lugs for each phase, neutral and ground, if applicable. The lugs shall accommodate up to #2 AWG copper conductor.

M. Enclosure: Units shall be provided in a NEMA 1 type enclosure of 14 gauge steel or be integral to switchboard.

2.3 WARRANTY

A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in

addition to, and run concurrent with, other warranties made by Contractor under the Contract Documents.

B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of surge suppressors that fail in materials or workmanship with five (5) years from date of Substantial Completion.

PART 3 - EXECUTION

3.1 INSTALLATION

A. At service entrance, install on load side of main with ground lead bonded to service entrance ground.

B. TVSS devices shall be installed adjacent to or in switchboards in accordance with final submitted drawings and with manufacturer's written instructions.

C. Circuit breaker or fused disconnect integral to the TVSS in accordance with manufacturers requirements. Fuses rated at 200 kA interrupting capacity.

D. Wiring from the bus to the TVSS shall not exceed 6 feet length and shall avoid unnecessary bends.

E. Coordinate location of field mounted suppressors to allow adequate clearance for maintenance.

F. All terminations shall be made with compression lugs.

3.2 FACTORY TESTING

A. Conduct manufacturer's standard factory tests per approved submittal data.

B. Submit formal report of factory tests within ten (10) days of factory tests, stating tests conducted, acceptable limits of such tests, actual test results, and original test data sheet with legible signatures of those conducting, witnessing, and approving such tests.

C. Testing: Perform the following field quality control testing:

1. After installing surge protective devices, but before electrical circuitry has been energized, test for compliance with requirements.

2. Complete startup checks according to manufacturer's written instructions.

3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.19. Certify compliance with test parameters.

4. Repair or replace malfunctioning units. Retest after repairs or replacements are made.

3.3 TESTS

A. The TVSS shall be tested per manufacturer's instructions.

END OF SECTION 26 4313

SECTION 26 5119 – LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Interior solid-state luminaires that use LED technology.

2. Lighting fixture supports.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.

2. Include data on features, accessories, and finishes.

3. Include physical description and dimensions of luminaires.

4. Include emergency lighting units, including batteries and chargers.

5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.

6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project IES LM-79, IES LM-80 and IESNA TM-21-11.
   a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
   b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

7. Include lighting calculations for each space using standard reflectances and working plane height of 30" AFF for comparison to Basis of Design.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.

2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing laboratory providing photometric data for luminaire.

B. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.

1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

C. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Product Certificates: For each type of luminaire.

E. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

F. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B. Seismic Performance: Luminaires and LEDs shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event.

2.2 LUMINAIRE REQUIREMENTS

A. Luminaires on this project have been prior approved and only those indicated on Luminaire Schedule are allowed to bid this project

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

D. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

E. Recessed Fixtures: Comply with NEMA LE 4.

F. CRI of minimum 80. CCT of 3500K.

G. Rated lamp life of 50,000 hours.

H. LEDs dimmable from 100 percent to 0 percent of maximum light output.

2.3 INTERNAL LINEAR DRIVER

A. Luminaires on this project have been prior approved and only those indicated on Luminaire Schedule are allowed to bid this project

B. Physical Characteristics

1. Driver shall be available in an all metal-can construction for optimal thermal performance.

2. Driver shall have a slim profile with height ≤ 1 in and width ≤ 1.2 in.

3. Driver shall be provided with integral color-coded connectors.

C. Performance Requirements

1. Driver shall operate from 50/60 Hz input source of 120V through 277V with sustained variations of +/- 10% (voltage) with no damage to the Driver.

2. Driver output shall be regulated to +/- 5% across published load range.

3. Driver shall have an easy way to lower the output current, without using the dimming leads.

4. Driver shall have a Power Factor greater than 0.90 for primary application to 50% of full load rating.

5. Driver input current shall have Total Harmonic Distortion (THD) of less than 20% to 50% of full load rating.

6. Driver shall have a Class A sound rating.

7. Driver shall have a minimum operating temperature of -20C (-4F).

8. Driver shall tolerate sustained open circuit and short circuit output conditions without fail and auto-resetting without need for external fuses or trip devices.

9. Driver output ripple current shall be less than 15% measured peak-to-average, with ripple frequency >100Hz.

10. Driver performance requirements shall be met when operated to 50% of full load rating.

11. Driver shall be rated for UL Damp and Dry locations.

12. Driver shall have integral common mode and differential mode surge protection of 2.5kV(100kHz 30ohm ring wave).

13. Driver shall have integral thermal foldback to reduce driver power above rated case temperature to protect the driver if temperatures reach unacceptable levels.

14. Driver shall comply with NEMA 410 for in-rush current limits.

15. Driver shall incorporate an integral means of limiting surges to the LEDs.

D. Regulatory

1. Driver shall not contain any Polychlorinated Biphenyl (PCB).

2. Driver shall be Underwriters Laboratories (UL) recognized Class 2 per UL1310 or Canadian Standards Association (CSA) recognized Class 2 per CSA-C22.2.

3. Driver shall comply with applicable requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 15, for Non-Consumer equipment.

4. Driver shall be RoHS compliant.

E. Other

1. Driver shall be manufactured in a factory certified to ISO 9001 Quality System Standards.

2. Driver shall carry a five-year limited warranty from date of manufacture against defects in material or workmanship, including replacement, for operation at a maximum case temperature of 75C

3. Dimmable drivers shall be controlled by a Class 2 low voltage 0-10VDC controller with dimming range controlled between 1 and 8VDC with source current 150µA.

4. Manufacturer shall have a 10-year history of producing electronic drivers for the North American market.

F. Nominal Operating Voltage: Multi tap drivers will provide 120Vac and/or 277Vac.

2.4 INTERNAL DOWNLIGHT DRIVER

A. Luminaires on this project have been prior approved and only those indicated on Luminaire Schedule are allowed to bid this project

B. Physical Characteristics

1. Driver shall be available in an all metal-can construction for optimal thermal performance.

2. Driver shall be in a compact enclosure with integrated studs so that it can be mounted on the outside or a junction box, without the need of an additional enclosure.

3. Driver shall be provided with integral color-coded connectors.

C. Performance Requirements

1. Driver shall operate from 50/60 Hz input source of 120V through 277V with sustained variations of +/- 10% (voltage) with no damage to the Driver.

2. Driver output shall be regulated to +/- 5% across published load range.

3. Driver shall have an easy way to lower the output current, without using the dimming leads.

4. Driver shall have a Power Factor greater than 0.90 for primary application to 50% of full load rating.

5. Driver input current shall have Total Harmonic Distortion (THD) of less than 20% to 50% of full load rating.

6. Driver shall have a Class A sound rating.

7. Driver shall have a minimum operating temperature of -20C (-4F).

8. Driver shall tolerate sustained open circuit and short circuit output conditions without fail and auto-resetting without need for external fuses or trip devices.

9. Driver output ripple current shall be less than 15% measured peak-to-average, with ripple frequency >100Hz.

10. Driver performance requirements shall be met when operated to 50% of full load rating.

11. Driver shall be rated for UL Damp and Dry locations.

12. Driver shall have integral common mode and differential mode surge protection of 2.5kV(100kHz 30ohm ring wave).

13. Driver shall have integral thermal foldback to reduce driver power above rated case temperature to protect the driver if temperatures reach unacceptable levels.

14. Driver shall comply with NEMA 410 for in-rush current limits.

15. Driver shall incorporate an integral means of limiting surges to the LEDs.

D. Regulatory

1. Driver shall not contain any Polychlorinated Biphenyl (PCB).

2. Driver shall be Underwriters Laboratories (UL) recognized Class 2 per UL1310 or Canadian Standards Association (CSA) recognized Class 2 per CSA-C22.2.

3. Driver shall comply with applicable requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 15, for Non-Consumer equipment.

4. Driver shall be RoHS compliant.

E. Other

1. Driver shall be manufactured in a factory certified to ISO 9001 Quality System Standards.

2. Driver shall carry a five-year limited warranty from date of manufacture against defects in material or workmanship, including replacement, for operation at a maximum case temperature of 75C.

3. Dimmable drivers shall be controlled by a Class 2 low voltage 0-10VDC controller with dimming range controlled between 1 and 8VDC with source current 150μA.

4. Manufacturer shall have a 10-year history of producing electronic drivers for the North American market.

5. Nominal Operating Voltage: Multi tap drivers will provide 120Vac and/or 277Vac

2.5 DOWNLIGHT

A. Luminaires on this project have been prior approved and only those indicated on Luminaire Schedule are allowed to bid this project.

B. Minimum 1,000 lumens. Minimum allowable efficacy of 80 lumens per watt. Unless noted otherwise on luminaires schedule.

C. Universal mounting bracket.

D. Integral junction box with conduit fittings.

2.6 STRIP LIGHT

A. Luminaires on this project have been prior approved and only those indicated on Luminaire Schedule are allowed to bid this project.

B. Minimum 750 lumens. Minimum allowable efficacy of 80 lumens per watt.

C. Integral junction box with conduit fittings.

2.7 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.

2. Sheet metal components shall be steel unless otherwise indicated.

3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit new LEDs without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during replacement and when secured in operating position.

C. Housings:

1. Will be as called for in the Luminaire Schedule for this project. This will include housing and heat sink.

2. Powder-coat and painted finish. Unless otherwise noted in the luminaire schedule for this project.

D. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:
   a. "USE ONLY" and include specific lamp type.
   b. Lamp diameter, shape, size, wattage, and coating.
   c. CCT and CRI for all luminaires.

2.8 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.9 LUMINAIRE FIXTURE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.

2. Able to maintain luminaire position after cleaning and replacement of LEDs.

3. Provide support for luminaire without causing deflection of ceiling or wall.

4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaire Support:

1. Secured to outlet box.

2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.

3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaire Support:

1. Attached using through bolts and backing plates on either side of wall as means of attachment.

2. Do not attach luminaires directly to gypsum board.

G. Ceiling-Recessed-Mounted Luminaires:

1. Secure to any required outlet box.

2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.

3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

H. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

D. Adjusting

E. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace drivers or luminaires that are defective.

2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 26 5119

SECTION 26 5219 – EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Emergency lighting units.

2. Exit signs.

3. Luminaire supports.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.

D. Fixture: See "Luminaire" Paragraph.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.

1. Include data on features, accessories, and finishes.

2. Include physical description of the unit and dimensions.

3. Battery and charger for light units.

4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.

5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
    a. Testing Agency Certified Data: For indicated luminaires and signs, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires and signs shall be certified by manufacturer.
    b. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring.

C. Samples: For each product and for each color and texture specified.

D. Samples for Initial Selection: For each type of luminaire with factory-applied finishes.

E. Samples for Verification: For each type of luminaire.

1. Include Samples of luminaires and accessories to verify finish selection.

F. Product Schedule:

1. For emergency lighting units. Use same designations indicated on Drawings.

2. For exit signs. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Luminaires.

2. Suspended ceiling components.

3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.

4. Structural members to which equipment will be attached.

5. Size and location of initial access modules for acoustical tile.

6. Items penetrating finished ceiling including the following:

a. Other luminaires.
b. Air outlets and inlets.
c. Speakers.
d. Ceiling-mounted projectors.
e. Sprinklers.
f. Access panels.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Product Certificates: For each type of luminaire.

D. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

4. Provide seismic qualification certificate for each piece of equipment.

E. Product Test Reports: For each luminaire for tests performed by a qualified testing agency.

F. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. LED boards: 10 for every 100 of each type and rating installed. Furnish at least one of each type.

2. Luminaire-mounted, emergency battery pack: One for every 20 emergency lighting units. Furnish at least one of each type.

3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of luminaires and signs in mockups before starting installations.

2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two year(s) from date of Substantial Completion.

B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Power Unit Batteries: Five years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining four years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. Luminaires and LEDs shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

A. Luminaires on this project have been prior approved and only those indicated on Luminaire Schedule are allowed to bid this project

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.

D. Comply with NFPA 70 and NFPA 101.

E. Comply with NEMA LE 4 for recessed luminaires.

F. Comply with UL 1598 for fluorescent luminaires.

G. Lamp Base: Comply with ANSI C81.61 or IEC 60061-1.

H. Bulb Shape: Complying with ANSI C79.1.

I. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with LED Driver.

1. Emergency Connection: Operate one LED board continuously at an output of 1100 lumens each upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.

2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature: Less than 0 deg F or exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.
   b. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
   c. Humidity: More than 95 percent (condensing).
   d. Altitude: Exceeding this project site in feet.

4. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
   a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

5. Battery: Sealed, maintenance-free, nickel-cadmium type.

6. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

7. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.3 EXIT SIGNS

A. Luminaires on this project have been prior approved and only those indicated on Luminaire Schedule are allowed to bid this project

B. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

C. Internally Lighted Signs:

1. Manufacturers: Luminaires on this project have been prior approved and only those indicated on Luminaire Schedule are allowed to bid this project.

2. Operating at nominal voltage of 120 V ac, 277 V ac.

3. Lamps for AC Operation: Fluorescent, two for each luminaire; 20,000 hours of rated lamp life.

4. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.

5. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.

6. Master/Remote Sign Configurations:
   a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply for power connection to remote unit.
   b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.4 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.

2. Sheet metal components shall be steel unless otherwise indicated.

3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.

2. Designed to permit relamping without use of tools.

3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Diffuse glass.

2. Glass: Annealed crystal glass unless otherwise indicated.

3. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

4. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Housings:

1. Extruded aluminum housing and heat sink.

2. Clear anodized finish.

E. Conduit: Electrical metallic tubing, minimum 3/4 inch in diameter.

2.5 METAL FINISHES

A. Appearance of Finished Work: Noticeable variations in same piece 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.

2.6 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire and emergency power unit weight.

2. Able to maintain luminaire position when testing emergency power unit.

3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.

4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.

E. Wall-Mounted Luminaire Support:

1. Attached to a minimum 20-gage backing plate attached to wall structural members.

2. Do not attach luminaires directly to gypsum board.

F. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.

2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.

3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.

4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

G. Ceiling Grid Mounted Luminaires:

1. Secure to any required outlet box.

2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.

3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

D. Spare Exit signs:

1. Provide 10% spare exit of the total installed in this facility.

2. These spare units will be utilized and installed per AHJ final inspection of egress paths. Should AHJ request additional exit signs these spare will be installed as directed.

3. Owner will bear no cost for these spare and any installation due to AHJ requirement to add additional exit signs.

4. Any exit signs not used will be given to owner.

3.5 STARTUP SERVICE

A. Perform startup service:

1. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

3.6 ADJUSTING

A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:

1. Inspect all luminaires. Replace lamps, emergency power units, batteries, signs, or luminaires that are defective.
   a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

2. Conduct short-duration tests on all emergency lighting.

END OF SECTION 26 5219

SECTION 26 5619 – LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.

2. Luminaire supports.

3. Luminaire-mounted photoelectric relays.

B. Related Requirements:

1. Division 26, Section 26 5119, LED Interior Lighting, for interior Luminaires, and accessories.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Luminaire: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including LEDs, Drivers, Reflector, and Housing.

1.4 ACTION SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections

B. Product Data: For each type of luminaire.

1. Arrange in order of luminaire schedule designation.

2. Include data on features, accessories, and finishes.

3. Include physical description and dimensions of luminaire.

4. LEDs, include life, output (lumens, CCT, and CRI), and energy-efficiency data.

5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for LEDs and accessories identical to those indicated for the luminaire as applied in this Project; IES LM-79 and IES LM-80
   a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
   b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

6. Wiring diagrams for power, control, and signal wiring. Wiring diagrams for control system showing both factory-installed and field-installed wiring for specific system of this Project, and differentiating between factory-installed and field-installed wiring.

7. Photoelectric relays.

8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

9. Luminaire, LEDs, Drivers, Poles, and accessories. Include data on features, Poles, accessories, finishes, and the following:
   a. Outline drawings indicating dimensions and principal features of Luminaire and Poles.
   b. Electrical Ratings and Photometric Data: Certified results of independent laboratory tests for Luminaires and LEDs.

10. Wind Resistance Calculations: Certified by a registered professional engineer

11. Anchor-Bolt Templates: Keyed to specific poles and certified by manufacturer.

12. Field test reports indicating and interpreting test results specified in Part 3 of this section.

13. Maintenance data for products to include in the operation and maintenance manual specified in Division 1.

14. Product certificates signed by manufacturers of lighting units certifying that their products comply with specified requirements.

C. Include lighting calculations for each space using the following reflectance’s, 75,45,20, and working plane height of 30” AFF for comparison to Basis of Design

D. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.

2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, and required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring.

E. Samples: For each luminaire and for each color and texture indicated with factory-applied finish.

F. Delegated-Design Submittal: For luminaire supports.

1. Include design calculations for luminaire supports and seismic restraints.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Luminaires.

2. Structural members to which luminaires will be attached.

3. Underground utilities and structures.

4. Existing underground utilities and structures.

5. Above-grade utilities and structures.

6. Existing above-grade utilities and structures.

7. Building features.

8. Vertical and horizontal information.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Product Certificates: For each type of the following:

1. Luminaire.

2. Photoelectric relay.

E. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

F. Source quality-control reports.

G. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.

1. Provide a list of all LED types used on Project. Use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. LEDs: One for every 50 of each type and rating installed. Furnish at least one of each type.

2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.

3. Diffusers and Lenses: One for every 50 of each type and rating installed. Furnish at least one of each type.

4. Globes and Guards: One for every 50 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Listing and Labeling: Provide Luminaires and accessories specified in this Section that are listed and labeled for their indicated use and installation conditions on Project.

1. Special Listing and Labeling: Provide Luminaires for use underwater that are specifically listed and labeled for such use. Provide Luminaires for use in hazardous (classified) locations that are listed and labeled for the specific hazard.

2. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

3. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL where available.

E. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

F. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

G. Mockups: For exterior luminaires, complete with power and control connections.

1. Obtain Architect's approval of luminaires in mockups before starting installations.

2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

General: Store poles on decay-resistant treated skids at least 12 inches above grade and vegetation. Support pole to prevent distortion and arrange to provide free air circulation

Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

A. Metal Poles: Retain factory-applied pole wrappings until just before pole installation. For poles with nonmetallic finishes, handle with web fabric straps

1.10 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.11 WARRANTY

A. General Warranty: The warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents

B. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures, including luminaire support components.
   b. Faulty operation of luminaires and accessories.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering. Warranty against perforation or erosion of finish due to weathering.
   d. Color Retention: Warranty against fading, staining, and chalking due to effects of weather and solar radiation

2. Warranty Period: 5 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Luminaires on this project have been prior approved and only those indicated on Luminaire Schedule are allowed to bid this project.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to SCE/SEI 7.

B. Seismic Performance: Luminaires and LEDs shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.3 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. UL Compliance: Comply with UL 1598 and listed for wet location where indicated in Luminaire schedule.

E. Bulb shape complying with ANSI C79.1.

F. CRI of minimum 80.

G. CCT of 4100 K or as indicated in the luminaire schedule.

H. L70 LED life of 50,000 minimum hours.

I. Internal driver.

J. Nominal Operating Voltage: Multi-Tap Drivers - 120 V or 277 V.

K. In-line Fusing: Separate in-line fuse for each luminaire.

L. LED Rating: LED marked for outdoor use.

M. Source Limitations: Obtain luminaires from single source from a single manufacturer.

N. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

O. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed Luminaires.

P. Exposed Hardware Material: Stainless steel.

Q. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

R. Lenses and Refractors: Materials as indicated. Use heat- and aging-resistant, resilient gaskets to seal and cushion lens and refractor mounting in Luminaire doors.

2.4 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Stainless steel. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

D. Diffusers and Globes:

1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

2. Glass: Annealed crystal glass unless otherwise indicated.

3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.

2. Specular Surfaces: 83 percent.

3. Diffusing Specular Surfaces: 75 percent.

G. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.

2. Provide filter/breather for enclosed luminaires.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:
   a. "USE ONLY" and include specific lamp type.
   b. Lamp diameter, shape, size, wattage and coating.
   c. CCT and CRI for all luminaires.

2.5 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are not acceptable. Arm, Bracket, and Tenon Mount will match poles' finish.

B. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.

2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a. Color: As selected by Architect from manufacturer's full range.

C. Mountings, Fastenings, and Appurtenances: Corrosion-resistant items compatible with support components. Use materials that will not cause galvanic action at contact points. Use mountings that correctly position luminaire to provide indicated light distribution.

2.6 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 26 0529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Pole-Mounted Luminaires: Conform to AASHTO LTS-3.

C. Wind-load strength of total support assembly, including pole, arms, appurtenances, base, and anchorage, is adequate to carry itself plus Luminaires indicated at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 100 Mi./Hr. with a gust factor of 1.3.

D. Poles: Provide factory installed vibration dampers.

E. Pole Shafts: Round, straight.

F. Pole Bases: Anchor type with galvanized steel hold-down or anchor bolts, leveling nuts, and bolt covers.

G. Poles: Steel tubing conforming to ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psi. Poles are 1-piece construction up to 40 feet in length and have access handhole in wall.

H. Metal Pole Grounding Provisions: Welded 1/2-inch threaded lug, accessible through handhole.

I. Steel Mast Arms: Fabricated from 2-inch NPS (DN50) black steel pipe, continuously welded to pole attachment plate with span and rise as indicated.

J. Metal Pole Brackets: Designed to match pole metal. Provide cantilever brackets without underbrace, in sizes and styles indicated, with straight tubular end section to accommodate Luminaire.

K. Pole-Top Tenons: Fabricated to support Luminaire or Luminaires and brackets indicated and securely fastened to pole top.

L. Concrete for Pole Foundations: Comply with structural details for the base required for Poles on this project. Details in this division drawings indicate electrical information and do not call out any structural information.

1. Construct according to Division 3, Section 03 3000, Cast-in-Place Concrete.

2. Comply with details and manufacturer's recommendations for reinforcing, anchor bolts, nuts, and washers. Verify anchor-bolt templates by comparing with actual pole bases furnished.

3. Finish: Trowel and rub smooth parts exposed to view

M. Embedded Poles: Set poles to indicated depth, but not less than 1/6 of pole length below finish grade. Dig holes large enough to permit use of tampers the full depth of hole. Backfill in 6-inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.

N. Pole Installation: Use web fabric slings (not chain or cable) to raise and set poles.

O. Luminaire Attachment: Fasten to indicated structural supports.

P. Luminaire Attachment with Adjustable Features or Aiming: Attach fixtures and supports to allow aiming for indicated light distribution.

Q. Provide LED Luminaires with indicated LEDs according to manufacturer's written instructions. Replace malfunctioning LEDs.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Examine walls, roofs, and overhang ceilings for suitable conditions where luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Install lamps in each luminaire.

D. Fasten luminaire to structural support.

1. Sized and rated for luminaire weight.

2. Able to maintain luminaire position after cleaning and relamping.

3. Support luminaires without causing deflection of finished surface.

4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

E. Wall-Mounted Luminaire Support:

1. Attached using through bolts and backing plates on either side of wall.

F. Wiring Method: Install cables in raceways. Conceal raceways and cables.

G. Set Luminaires securely according to manufacturer's written instructions and approved Shop Drawings. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at height and aiming angle as indicated on Drawings.

H. Coordinate layout and installation of luminaires with other construction.

I. Luminaire Attachment with Adjustable Features or Aiming: Attach fixtures and supports to allow aiming for indicated light distribution. Adjust luminaires that require field adjustment or aiming once luminaire is in place .

J. Comply with requirements in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables" and Section 26 0533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

K. Provide LED Luminaires with indicated LEDs according to manufacturer's written instructions. Replace malfunctioning LEDs

3.4 GROUNDING

A. Ground fixtures and metal poles according to Division 26, Section 26 0526, Grounding and Bonding for Electrical Systems.

1. Poles: Install 10-foot driven ground rod at each pole.

2. Nonmetallic Poles: Ground metallic components of lighting unit and foundations. Connect fixtures to grounding system with No. 6 AWG conductor, minimum

3.5 CORROSION PREVENTION

A. Steel Conduits: Comply with Section 26 0533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Give advance notice of dates and times for field tests.

C. Provide instruments to make and record test results. Use photometers with calibration referenced to National Institute of Standards and Technology (NIST) standards.

D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing luminaires, control system, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

2. Verify operation of photoelectric controls.

3. Check for intensity of illumination.

4. Check for uniformity of illumination.

5. Check for excessively noisy Driver.

E. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):
   a. IES LM-5.
   b. IES LM-50.
   c. IES LM-52.
   d. IES LM-64.
   e. IES LM-72.

F. Luminaire will be considered defective if it does not pass tests and inspections. Replace or repair damaged and malfunctioning units, make necessary adjustments, and retest. Repeat procedure until all units operate properly

G. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaires.

3.9 ADJUSTING

A. Clean units after installation. Use methods and materials recommended by manufacturer. Adjust aimable fixtures to provide required light intensities.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace LEDs or luminaires that are defective.

2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3. Adjust the aim of luminaires in the presence of the Architect.

3.10 EXTERIOR LIGHTING FIXTURE SCHEDULE

A. The luminaire schedule located in the construction drawings describes each type of luminaire for the project. Manufacturer’s catalog numbers are given for convenience. Where discrepancies occur between catalog numbers and the descriptive information, the descriptive information shall take precedence. Some required features, options, accessory equipment or special order requirements may not be included in the catalog number.

3.11 SPARE MATERIAL

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. All extra material will be delivered to the location as directed by the district. Provide TWO spare luminaires of each type.

B. LED: Five for every 100 of each type and rating installed for each type of luminaire. Furnish at least one of each type in every instance.

C. Diffusers and Lenses: Five for every 100 of each type and rating installed for each type of luminaire. Furnish at least one of each type in every instance.

D. LED Drivers: Five for every 100 of each type and rating installed. Furnish at least one of each type.

END OF SECTION 26 5619

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Division 28 –

Electrical Safety & Security

SECTION 283100 - INTRUSION DETECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Intrusion detection with communication links to perform monitoring, alarm, and control functions.
2. Integration of other electronic and electrical systems and equipment.

B. Related Sections:

1. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for power cabling between master control units and field-mounted devices and control units.
2. **[Other Sections to be determined during CD phase]**

1.3 DEFINITIONS

A. CCTV: Closed-circuit television.

B. PIR: Passive infrared.

C. RFI: Radio-frequency interference.

D. UPS: Uninterruptible power supply.

E. Control Unit: System component that monitors inputs and controls outputs through various circuits.

F. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.

G. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.

H. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.

I. Standard Intruder: A person who weighs 100 lb (45 kg) or less and whose height is 60 inches (1525 mm) or less; dressed in a long-sleeved shirt, slacks, and shoes[**unless environmental conditions at the site require protective clothing**].

J. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.

K. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.

L. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.4 ACTION SUBMITTALS

A. Product Data: Components for sensing, detecting[**, systems integration**], and control, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.

1. Functional Block Diagram: Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections. Indicate methods used to achieve systems integration. Indicate control, signal, and data communication paths and identify [**programmable logic controllers**] [**networks**] [**and**] control interface devices and media to be used. Describe characteristics of network and other data communication lines.

    a. Indicate methods used to achieve systems integration.
    b. Indicate control, signal, and data communication paths and identify PLCs, networks, control interface devices, and media to be used.
    c. Describe characteristics of network and other data communication lines.
    d. Describe methods used to protect against power outages and transient voltages including types and ratings of isolation and surge suppression devices used in data, communication, signal, control, and ac and dc power circuits.

2. Raceway Riser Diagrams: Detail raceway runs required for intrusion detection[**and for systems integration**]. Include designation of devices connected by raceway, raceway type and size, and type and size of wire and cable fill for each raceway run.
3. UPS: Sizing calculations.
4. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building.[**Include room layout for master control-unit console, terminal cabinet, racks, and UPS.**]
5. Master Control-Unit Console Layout: Show required artwork and device identification.
6. Device Address List: Coordinate with final system programming.
7. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.

8. Details of surge-protection devices and their installation.
9. Sensor detection patterns and adjustment ranges.

C. Design Data: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**] [**intrusion detection systems integrator**] [**testing agency**].

B. Field quality-control reports.

1. Anchor inspection reports documenting inspections of built-in and cast-in anchors.

C. Product Warranty: Sample of special warranty.

D. Field Test Reports: Test plan and report defining all tests required to ensure that system meets technical, operational, and performance specifications within [**60 days**] <**Insert number**> of date of Contract award.

E. Evaluation Reports: Examination reports documenting inspections of substrates, areas, and conditions.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For intrusion detection system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Data for each type of product, including features and operating sequences, both automatic and manual.
2. Master control-unit hardware and software data.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Intrusion Detection Devices: Furnish quantity equal to [**five**] <**Insert number**> percent of the number of units of each type installed, but no fewer than one of each type.
2. Fuses: [**Three**] <**Insert number**> of each kind and size.
3. Tool Kit: Provide [**six**] <**Insert number**> sets of tools for use with security fasteners, each packaged in a compartmented kit configured for easy handling and storage.

4. Security Fasteners: Furnish no fewer than [**1 box for every 50**] <**Insert numbers**> boxes or fraction thereof, of each type and size of security fastener installed.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. An employer of workers, at least one of whom is a Certified Alarm Technician, Level 1.
2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
3. Layout Responsibility: Preparation of Shop Drawings[**and cabling administration Drawings**][**, cabling administration Drawings, and field testing program development**] by [**an RCDD**] [**a Technician**].
4. Installation Supervision: Installation shall be under the direct supervision of [**Technician**] [**Level 2 Commercial Installer**], who shall be present at all times when Work of this Section is performed at Project site.
5. Testing Supervisor: Currently certified by BICSI as [**an RCDD**] [**a Technician**] to supervise on-site testing.

B. Intrusion Detection Systems Integrator Qualifications: An experienced intrusion detection equipment supplier[**and Installer**] who has completed systems integration work for installations similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

1. At least one of whom is a Certified Systems Integrator.

C. Testing Agency Qualifications: Certified by BICSI.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.9 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Altitude: Sea level to [**4000 feet (1220 m)**] <**Insert elevation**>.
2. Master Control Unit: Rated for continuous operation in an ambient of 60 to 85 deg F (16 to 29 deg C) and a relative humidity of 20 to 80 percent, noncondensing.
3. Interior, Controlled Environment: System components, except master control unit, installed in [**air-conditioned**] [**temperature-controlled**] interior environments shall be rated for continuous operation in ambients of [**36 to 122 deg F (2 to 50 deg C)**] <**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, noncondensing.
4. Interior, Uncontrolled Environment: System components installed in [**non-air-conditioned**] [**non-temperature-controlled**] interior environments shall be rated for continuous operation in ambients of [**0 to 122 deg F (minus 18 to plus 50 deg C)**] <**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, noncondensing.

5. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambients of [**minus 30 to plus 122 deg F (minus 34 to plus 50 deg C)**] <**Insert temperature range**> dry bulb and 20 to 90 percent relative humidity, condensing. Comply with UL 294 and UL 639 for outdoor-use equipment. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to [**85 mph (137 km/h)**] [**and snow cover up to 24 inches (610 mm) thick**].
6. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings shall be rated, listed, and installed according to NFPA 70.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**] <**Insert number**> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Description: [**Hard-wired**] [**Multiplexed**], modular, microprocessor-based controls, intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.

B. Supervision: System components shall be continuously monitored for normal, alarm, [**supervisory,**] and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.

1. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
2. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.
3. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.

C. System Control: Master control unit shall directly monitor intrusion detection units and connecting wiring.

D. System Control: Master control unit shall directly monitor intrusion detection devices[**, perimeter detection units,**] [**, control units associated with perimeter detection units,**] and connecting wiring in a multiplexed distributed control system or as part of a network.

E. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.

F. Operator Commands:

1. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
2. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
3. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
4. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
5. Protected Zone Test: Initiate operational test of a specific protected zone.
6. System Test: Initiate system-wide operational test.
7. Print reports.

G. Timed Control at Master Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.

H. Automatic Control of Related Systems: Alarm or supervisory signals from certain intrusion detection devices control the following functions in related systems:

1. Switch selected lights.
2. Shift elevator control to a different mode.
3. Open a signal path between certain intercommunication stations.
4. Shift sound system to "listening mode" and open a signal path to certain system speakers.
5. Switch signal to selected monitor from CCTV camera in vicinity of sensor signaling an alarm.
6. <**Insert description of automatic control required**>.

I. Printed Record of Events: Print a record of alarm, supervisory, and trouble events on system printer. Sort and report by protected zone, device, and function. When master control unit receives a signal, print a report of alarm, supervisory, or trouble condition. Report type of signal (alarm, supervisory, or trouble), protected zone description, date, and time of occurrence. Differentiate alarm signals from other indications. When system is reset, report reset event with the same information concerning device, location, date, and time. Commands shall initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.

J. Response Time: [**Two**] <**Insert number**> seconds between actuation of any alarm and its indication at master control unit.

K. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from master control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.

L. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at

scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.

M. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.

2.2 SYSTEM COMPONENT REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Control Units, Devices, and Communications with Monitoring Station: Listed and labeled by a qualified testing agency for compliance with SIA CP-01.

C. FM Global Compliance: FM-Approved and -labeled intrusion detection devices and equipment.

D. Comply with NFPA 70.

E. Compatibility: Detection devices and their communication features, connecting wiring, and master control unit shall be selected and configured with accessories for full compatibility with the following equipment:

1. Door hardware specified in Section 087100 "Door Hardware."
2. Door hardware specified in Section 087111 "Door Hardware (Descriptive Specification)."
3. Elevators specified in Section 142100 "Electric Traction Elevators."
4. Elevators specified in Section 142400 "Hydraulic Elevators."
5. Lighting controls specified in Section 260923 "Lighting Control Devices."
6. Lighting controls specified in Section 260943.16 "Addressable-Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls."
7. Intercom and program systems specified in Section 275123.20 "Commercial Intercommunications and Program Systems."
8. Intercom and program systems specified in Section 275123.50 "Educational Intercommunications and Program Systems."
9. Public address and mass notification systems specified in Section 275116 "Public Address and Mass Notification Systems."
10. Access control system specified in Section 281300 "Access Control System Software and Database Management."
11. Fire alarm system specified in Section 284621.11 "Addressable Fire-Alarm Systems."
12. Fire alarm system specified in Section 284621.13 "Conventional Fire-Alarm Systems."
13. Perimeter security system specified in Section 283121 "Perimeter Security Systems."
14. Video surveillance system specified in Section 282000 "Video Surveillance."
15. <**Insert system or equipment**> specified in Section <**Insert Section number**> "<**Insert Section title**>."

F. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.

1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.

G. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.

H. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V rms injected into power supply lines at 10 to 10,000 MHz.

I. Tamper Protection: Tamper switches on detection devices, control units, annunciators, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Master control-unit alarm display shall identify tamper alarms and indicate locations.

J. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.

K. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to master control unit as an alarm signal.

L. Addressable Devices: Transmitter and receivers shall communicate unique device identification and status reports to master control unit.

M. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at master control unit for calibration, sensitivity, and alarm condition.

2.3 ENCLOSURES

A. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.

B. Interior Electronics: NEMA 250, Type 12.

C. Exterior Electronics: NEMA 250, Type 4X, [**fiberglass**] [**stainless steel**].

D. Corrosion Resistant: NEMA 250, Type 4X, [**PVC**] [**stainless steel**].

E. Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

2.4 SECURE AND ACCESS DEVICES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Keypad and Display Module: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.

C. Key-Operated Switch: Change protected zone between secure and access conditions.

2.5 DOOR AND WINDOW SWITCHES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Balanced-magnetic switch, complying with UL 634, installed on frame with integral overcurrent device to limit current to 80 percent of switch capacity. Bias magnet and minimum of [**two**] [**three**] encapsulated reed switches shall resist compromise from introduction of foreign magnetic fields.

C. Flush-Mounted Switches: Unobtrusive and flush with surface of door and window frame.

D. Overhead Door Switch: Balanced-magnetic type, listed for outdoor locations, and having door-mounted magnet and floor-mounted switch unit.

E. Remote Test: Simulate movement of actuating magnet from master control unit.

2.6 PIR SENSORS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.

C. Description: Sensors detect intrusion by monitoring infrared wavelengths emitted from a human body within their protected zone and by being insensitive to general thermal variations.

1. Wall-Mounted Unit Maximum Detection Range: 125 percent of indicated distance for individual units and not less than 50 feet (15 m).[**Provide adjustable coverage pattern as indicated.**]
2. Ceiling-Mounted Unit Spot-Detection Pattern: Full 360-degree conical.
3. Ceiling-Mounted Unit Pattern Size: 84-inch (2135-mm) diameter at floor level for units mounted 96 inches (2440 mm) above floor; 18-foot (5.5-m) diameter at floor level for units mounted 25 feet (7.6 m) above floor.

D. Device Performance:

1. Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg F (1 deg C) or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s) across two adjacent segments of detector's field of view.

2. Test Indicator: LED test indicator that is not visible during normal operation. When visible, indicator shall light when sensor detects an intruder. Locate test enabling switch under sensor housing cover.
3. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

2.7 MICROWAVE INTRUSION DETECTORS (INTERIOR)

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Device Performance: Microwave transmitter establishes an electromagnetic field in an adjustable detection pattern and detects intrusion by monitoring changes in that pattern.

1. Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s). Sensor sensitivity adjustments shall be accessible only when sensor housing is removed, and sensors shall comply with 47 CFR 15.
2. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test-enabling switch under sensor housing cover.
3. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

2.8 ACOUSTIC-TYPE, GLASS-BREAK SENSORS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Listed and labeled by a qualified testing agency for compliance with SIA GB-01.

C. Device Performance: Detect unique, airborne acoustic energy spectrum caused by breaking glass.

1. Sensor Element: Microprocessor-based, digital device to detect breakage of plate, laminate, tempered, and wired glass while rejecting common causes of false alarms. Detection pattern shall be at least a 20-foot (6-m) range.
2. Hookup Cable: Factory installed, not less than 72 inches (1830 mm).
3. Activation Indicator: LED on sensor housing that lights when responding to vibrations, remaining on until manually reset at sensor control unit[**or at master control unit**].
4. Control Unit: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
5. Glass-Break Simulator: A device to induce frequencies into protected glass pane that simulate breaking glass without causing damage to glass.

2.9 PIEZOELECTRIC-TYPE, GLASS-BREAK SENSORS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Listed and labeled by a qualified testing agency for compliance with SIA GB-01.

C. Device Performance: Detect unique, high-frequency vibrations caused by breaking glass.

1. Sensor Element: Piezoelectric crystals in a housing designed to mount directly to glass surface with adhesive provided by element manufacturer. Circular detection pattern, with at least a 60-inch (1525-mm) radius on a continuous glass pane. Sensor element shall not be larger than 4 sq. in. (25.80 sq. cm).
2. Hookup Cable: Factory installed, not less than 72 inches (1830 mm).
3. Activation Indicator: LED on sensor housing that lights when responding to vibrations, remaining on until manually reset at sensor control unit[**or at master control unit**].
4. Control Unit: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
5. Glass-Break Simulator: A device to induce frequencies into protected glass pane that simulate breaking glass without causing damage to glass.

2.10 VIBRATION SENSORS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Listed and labeled by a qualified testing agency for compliance with SIA GB-01.

C. Description: A sensor control unit and piezoelectric crystal sensor elements that are designed to be rigidly mounted to structure being protected.

D. Device Performance: Detects high-frequency vibrations generated by use of such tools as oxyacetylene torches, oxygen lances, high-speed drills and saws, and explosives that penetrate a structure while not responding to any other mechanical vibration.

1. Circular detection pattern, with at least a 72-inch (1830-mm) radius on protected structure.
2. Hookup Cable: Factory installed, not less than 72 inches (1830 mm).
3. Control Unit: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
4. Glass-Break Simulator: A device to induce frequencies to protected glass pane that simulate breaking glass without causing damage to glass.

2.11 PHOTOELECTRIC SENSORS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Device Performance: Detect an interruption of a pulsed, infrared, light beam that links transmitter and receiver.

1. Sensitivity: Detect standard-intruder movement within sensor's detection patterns at any speed of less than 7.5 fps (2.3 m/s) though the beam. Allow installation of multiple sensors within same protected zone that will not interfere with each other.

2. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test enabling switch under sensor housing cover.
3. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

2.12 MICROWAVE-PIR DUAL-TECHNOLOGY SENSORS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Single unit combining a sensor that detects changes in microwave signals and a PIR sensor that detects changes in ambient level of infrared emissions caused by standard-intruder movement within detection pattern.

C. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.

D. Device Performance: An alarm is transmitted when either sensor detects a standard intruder within a period of three to eight seconds from when the other sensor detects a standard intruder.

1. Minimum Detection Pattern: A room 20 by 30 feet (6 by 9 m).
2. PIR Sensor Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg F (1 deg C) or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s) across two adjacent segments of detector's field of view.
3. Microwave Sensor Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s). Sensor sensitivity adjustments shall be accessible only when sensor housing is removed, and sensors shall comply with 47 CFR 15.
4. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test enabling switch under sensor housing cover.
5. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

2.13 DURESS-ALARM SWITCHES

A. Description: A switch with a shroud over the activating lever that allows an individual to covertly send a duress signal to master control unit, with no visible or audible indication when activated. Switch shall lock in activated position until reset with a key.

1. Minimum Switch Rating: 50,000 operations.
2. Foot Rail: Foot activated, floor mounting.
3. Push Button: Finger activated, suitable for mounting on horizontal or vertical surface.

2.14 VIDEO MOTION SENSORS (INTERIOR)

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Device Performance: Detect changes in video signal within a user-defined protected zone. Provide an alarm output for each video input.

1. Detect movement within protected zone of standard intruders wearing clothing with a reflectivity that differs from that of background scene by a factor of 2. Reject all other changes in video signal.
2. Modular design that allows for expansion or modification of number of inputs.
3. Controls:

    a. Number of detection zones.
    b. Size of detection zones.
    c. Sensitivity of detection of each protected zone.

4. Mounting: Standard 19-inch (480-mm) rack as described in EIA/ECA 310-E.

2.15 MASTER CONTROL UNIT

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Supervise sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms and supervisory and trouble signals, and other indicated functions.

1. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
2. Include a real-time clock for time annotation of events on the event recorder and printer.
3. Addressable initiation devices that communicate device identity and status.
4. Control circuits for operation of mechanical equipment in response to an alarm.

C. Construction: [**Freestanding equipment rack**] [**Desk-mounted console**], modular, with separate and independent alarm and supervisory system modules. [**Alarm-initiating protected zone boards shall be plug-in cards.**]Arrangements that require removal of field wiring for module replacement are unacceptable.

D. Comply with [**UL 609**] [**UL 1023**] [**UL 1076**].

E. Console Controls and Displays: Arranged for interface between human operator at master control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: LCD, [**one**] [**two**] [**three**] line(s) of [**40**] [**80**] characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

3. Control-Unit Network: Automatic communication of alarm, status changes, commands, and other communications required for system operation. Communication shall return to normal after partial or total network interruption such as power loss or transient event. Total or partial signaling network failures shall identify the failure and record the failure at the annunciator display and at the system printer.
4. Field Device Network: Communicate between the control unit and field devices of the system. Communications shall consist of alarm, network status, and status and control of field-mounted processors. Each field-mounted device shall be interrogated during each interrogation cycle.
5. Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:

    a. Acknowledge alarm.
    b. Silence alarm.
    c. System reset.
    d. LED test.
    e. <**Insert operator functions**>.

6. Timing Unit: Solid state, programmable, 365 days.
7. Confirmation: Relays, contactors, and other control devices shall have auxiliary contacts that provide confirmation signals to system for their on or off status. Software shall interpret such signals, display equipment status, and initiate failure signals.
8. Alarm Indication: Audible signal sounds and an LED lights at master control unit identifying the [**protected zone**] [**addressable detector**] originating the alarm.[**Annunciator panel displays a common alarm light and sounds an audible tone.**]
9. Alarm Indication: Audible signal sounds and a plain-language identification of the [**protected zone**] [**addressable detector**] originating the alarm appears on [**LED**] [**or**] [**LCD**] display at master control unit.[**Annunciator panel displays a common alarm light and sounds an audible tone.**]
10. Alarm Indication: Audible signal sounds and a plain-language identification of the [**protected zone**] [**addressable detector**] originating the alarm appears on [**LED**] [**LCD**] [**or**] [**cathode-ray-tube**] display at master control unit.[**Annunciator panel alarm light and audible tone identify protected zone signaling an alarm.**]
11. Alarm activation sounds a [**bell**] [**siren**] [**strobe**] [**bell or siren and strobe**].

F. Protected Zones: Quantity of alarm and supervisory zones as indicated, with capacity for expanding number of protected zones by a minimum of [**25**] <**Insert number**> percent.

G. Power Supply Circuits: Master control units shall provide power for remote power-consuming detection devices. Circuit capacity shall be adequate for at least a [**25**] <**Insert number**> percent increase in load.

H. UPS: Comply with Section 263353 "Static Uninterruptible Power Supply." UPS shall be sized to provide a minimum of six hours of master control-unit operation.

I. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an

engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate shall not be less than 1 inch (25 mm) high. Identify, with permanent labels, individual components and modules within cabinets.

J. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.

K. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

2.16 AUDIBLE AND VISUAL ALARM DEVICES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Bell: 10 inches (254 mm) in diameter, rated to produce a minimum sound output of 84 dB at 10 feet (3 m) from master control unit.

1. Enclosure: Weather-resistant steel box equipped with tamper switches on cover and on back of box.

C. Klaxon Weatherproof Motor-Driven Hooter: UL listed, rated to produce a minimum sound output of 120 dB at 3 feet (1 m), plus or minus 3 dB, at a frequency of 470 Hz. Rated for intermittent use: two minutes on and five minutes off.

1. Designed for use in industrial areas and in high-noise, severe-weather marine environments.

D. Siren: 30-W speaker with siren driver, rated to produce a minimum sound output of 103 dB at 10 feet (3 m) from master control unit.

1. Enclosure: Weather-resistant steel box with tamper switches on cover and on back of box.

E. Strobe: Xenon light complying with UL 1638, with a clear polycarbonate lens.

1. Light Output: 115 cd, minimum.
2. Flash Rate: 60 per minute.

2.17 SECURITY FASTENERS

A. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.

B. <Double click here to find, evaluate, and insert list of manufacturers and products.>

C. Drive System Types: [**Pinned Torx-Plus**] [**pinned Torx**] [**or**] [**pinned hex (Allen)**].

D. Socket Flat Countersunk Head Fasteners:

1. Heat-treated alloy steel, ASTM F835 (ASTM F835M).
2. Stainless steel, ASTM F879 (ASTM F879M), Group 1 CW.

E. Socket Button Head Fasteners:

1. Heat-treated alloy steel, ASTM F835 (ASTM F835M).
2. Stainless steel, ASTM F879 (ASTM F879M), Group 1 CW.

F. Socket Head Cap Fasteners:

1. Heat-treated alloy steel, ASTM A574 (ASTM A574M).
2. Stainless steel, ASTM F837 (ASTM F837M), Group 1 CW.

G. Protective Coatings for Heat-Treated Alloy Steel:

1. Zinc chromate, ASTM F1135, Grade 3 or Grade 4, for exterior applications and interior applications where indicated.
2. Zinc phosphate with oil, ASTM F1137, Grade I, or black oxide unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of intrusion detection.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations of intrusion detection connections before intrusion detection installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of intrusion detection.

D. Inspect built-in and cast-in anchor installations, before installing intrusion detection, to verify that anchor installations comply with requirements. Prepare inspection reports.

1. Remove and replace anchors where inspections indicate that they do not comply with requirements. Reinspect after repairs or replacements are made.
2. Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.

E. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SYSTEM INTEGRATION

A. Integrate intrusion detection system with the following systems and equipment:

1. Electronic door hardware.
2. Elevators.
3. Network lighting controls.
4. Intercommunications and program systems.
5. Public address and mass notification systems.
6. Access control.
7. Fire-alarm system.
8. Perimeter security system.
9. Video surveillance.
10. <**Insert applicable systems and equipment**>.

3.3 SYSTEM INSTALLATION

A. Comply with UL 681 and NFPA 731.

B. Equipment Mounting: Install master control unit on finished floor with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 70548.16 "Seismic Controls for Communications Systems."

C. Install wall-mounted equipment, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 270548.16 "Seismic Controls for Communications Systems."

D. Connecting to Existing Equipment: Verify that existing perimeter security system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the Supervising Station.
3. Expand, modify, and supplement existing [**control**] [**monitoring**] equipment as necessary to extend existing [**control**] [**monitoring**] functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

E. Security Fasteners: Where accessible to inmates, install intrusion detection components using security fasteners with head style appropriate for fabrication requirements, strength, and finish of adjacent materials except that a maximum of two different sets of tools shall be required to operate security fasteners for Project.[**Provide stainless-steel security fasteners in stainless-steel materials.**]

3.4 WIRING INSTALLATION

A. Wiring Method: Install wiring in metal raceways according to Section 270528 "Pathways for Communications Systems." Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch (13 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.

B. Wiring Method: Install wiring in metal raceways according to Section 270528 "Pathways for Communications Systems," except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch (13 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.

C. Wiring Method: Cable, concealed in accessible ceilings, walls, and floors when possible.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Wires and Cables:

1. Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.
2. 120-V Power Wiring: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
3. Control and Signal Transmission Conductors: Install unshielded, twisted-pair cable unless otherwise indicated or if manufacturer recommends shielded cable, according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
4. Data and Television Signal Transmission Cables: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

G. Install power supplies and other auxiliary components for detection devices at control units unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.

H. Identify components with engraved, laminated-plastic or metal nameplate for master control unit and each terminal cabinet, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 270553 "Identification for Communications Systems."

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with identification requirements in Section 270553 "Identification for Communications Systems."

B. Install instructions frame in a location visible from master control unit.

3.6 GROUNDING

A. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.

B. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

C. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide [**5**] <**Insert value**>-ohm ground. Measure, record, and report ground resistance.

D. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Section 270526 "Grounding and Bonding for Communications Systems."

3.7 FIELD QUALITY CONTROL

A. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.

B. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

E. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."

1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
2. Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment shall be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."

F. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation."

G. Tag all equipment, stations, and other components for which tests have been satisfactorily completed.

3.8 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**] <**Insert number**> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**three**] <**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.[**Visits for this purpose shall be in addition to any required by warranty.**]

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**] [**Train**] Owner's maintenance personnel to adjust, operate, and maintain the intrusion detection system. Comply with documentation provisions in NFPA 731, Ch. 4, "Documentation and User Training."

END OF SECTION 28 3100

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NEW MEXICO
TEXAS
COLORADO

Division 31 –
Earthwork

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Clearing and protection of vegetation.

B. Removal of existing debris.

1.02 RELATED REQUIREMENTS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. Section 01 1000 - Summary: Limitations on Contractor's use of site and premises.

C. Section 01 1000 - Summary: Sequencing and staging requirements.

D. Section 01 5000 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.

E. Section 01 7000 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products.

F. Section 31 2200 - Grading: Topsoil removal.

G. Section 31 2200 - Grading: Fill material for filling holes, pits, and excavations generated as a result of removal operations.

H. Section 31 2323 - Fill: Fill material for filling holes, pits, and excavations generated as a result of removal operations.

I. Section 31 2323 - Fill: Filling holes, pits, and excavations generated as a result of removal operations.

1.03 QUALITY ASSURANCE

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

PART 2 PRODUCTS

2.01 MATERIALS

A. Fill Material: As specified in Section 31 2200 - Grading

PART 3 EXECUTION

3.01 SITE CLEARING

A. Comply with other requirements specified in Section 01 7000.

B. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

3.02 EXISTING UTILITIES AND BUILT ELEMENTS

A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.

B. Protect existing utilities to remain from damage.

C. Do not disrupt public utilities without permit from authority having jurisdiction.

D. Protect existing structures and other elements that are not to be removed.

3.03 VEGETATION

A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, playing fields, lawns, and planting beds.

B. Do not begin clearing until vegetation to be relocated has been removed.

C. Do not remove or damage vegetation beyond the following limits:

1. 40 feet outside the building perimeter.
2. 10 feet each side of surface walkways, patios, surface parking, and utility lines less than 12 inches in diameter.
3. 15 feet each side of roadway curbs and main utility trenches.
4. 25 feet outside perimeter of pervious paving areas that must not be compacted by construction traffic.
5. Exception: Specific trees and vegetation indicated on drawings to be removed.
6. Exception: Selective thinning of undergrowth specified elsewhere.

D. Install substantial, highly visible fences at least 3 feet high to prevent inadvertent damage to vegetation to remain:

1. At vegetation removal limits.
2. Around trees to remain within vegetation removal limits; locate no closer to tree than at the drip line.
3. Around other vegetation to remain within vegetation removal limits.

E. In areas where vegetation must be removed but no construction will occur other than pervious paving, remove vegetation with minimum disturbance of the subsoil.

F. Vegetation Removed: Do not burn, bury, landfill, or leave on site, except as indicated.

1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes;

preference should be given to on-site uses.

2. Trees: Sell if marketable; if not, treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches.
3. Sod: Re-use on site if possible; otherwise sell if marketable, and if not, treat as specified for other vegetation removed.
4. Fill holes left by removal of stumps and roots, using suitable fill material, with top surface neat in appearance and smooth enough not to constitute a hazard to pedestrians.

G. Dead Wood: Remove all dead trees (standing or down), limbs, and dry brush on entire site; treat as specified for vegetation removed.

H. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner.

3.04 DEBRIS

A. Remove debris, junk, and trash from site.

B. Leave site in clean condition, ready for subsequent work.

C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION 31 1000

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Removal of topsoil.

B. Rough grading and clearing the site for structures, building pads, and roadway improvements.

C. Finish grading.

1.02 RELATED REQUIREMENTS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. Section 31 1000 - Site Clearing.

C. Section 31 2316 - Excavation.

D. Section 31 2323 - Fill: Filling and compaction.

1.03 SUBMITTALS

A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.04 QUALITY ASSURANCE

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

1.05 PROJECT CONDITIONS

A. Protect above- and below-grade utilities that remain.

B. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from grading equipment and vehicular traffic.

PART 2 PRODUCTS

2.01 MATERIALS

A. Topsoil: See Section 31 2323.

B. Other Fill Materials: See Section 31 2323.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench mark and intended elevations for the Work are as indicated.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Stake and flag locations of known utilities.

C. Locate, identify, and protect from damage above- and below-grade utilities to remain.

D. Notify utility company to remove and relocate utilities.

3.03 ROUGH GRADING

A. Remove topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials.

B. Do not remove topsoil when wet.

C. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.

D. Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.

E. When excavating through roots, perform work by hand and cut roots with sharp axe.

F. See Section 31 2323 for filling procedures.

G. Benching Slopes: Horizontally bench existing slopes greater than 1:4 to key fill material to slope for firm bearing.

H. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.

3.04 SOIL REMOVAL

A. Remove excavated topsoil from site.

B. Stockpile excavated subsoil on site.

C. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet; protect from erosion.

3.05 FINISH GRADING

A. Before Finish Grading:

1. Verify building and trench backfilling have been inspected.
2. Verify subgrade has been contoured and compacted.

B. Remove debris, roots, branches, stones, in excess of 1/2 inch in size. Remove soil contaminated with petroleum products.

C. Where topsoil is to be placed, scarify surface to depth of 3 inches.

D. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 inches.

E. Place topsoil in areas where seeding are indicated.

F. Place topsoil where required to level finish grade.

G. Place topsoil to thickness as scheduled.

H. Place topsoil during dry weather.

I. Remove roots, weeds, rocks, and foreign material while spreading.

J. Near plants spread topsoil manually to prevent damage.

K. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.

L. Lightly compact placed topsoil.

3.06 TOLERANCES

A. Top Surface of Subgrade: Plus or minus 0.10 foot (1-3/16 inches) from required elevation.

B. Top Surface of Finish Grade: Plus or minus 0.04 foot (1/2 inch).

C. Top Surface of Subgrade: Plus or minus 1/10 foot from required elevation.

D. Top Surface of Finish Grade: Plus or minus 1/2 inch.

3.07 FIELD QUALITY CONTROL

A. See Section 31 2323 for compaction density testing.

3.08 CLEANING

A. Remove unused stockpiled topsoil and subsoil. Grade stockpile area to prevent standing water.

B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION 31 2200

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Backfilling and compacting for utilities outside the building to utility main connections.

1.02 RELATED REQUIREMENTS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. Section 31 2200 - Grading: Site grading.

C. Section 31 2316 - Excavation: Building and foundation excavating.

D. Section 31 2323 - Fill: Backfilling at building and foundations.

1.03 REFERENCES

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 in.) Drop; American Association of State Highway and Transportation Officials; 2010.

C. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates; 2006.

D. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2012.

E. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 2007.

F. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN m/m3)); 2012.

G. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 2008.

H. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2011.

I. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 2005.

J. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 2005.

K. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 2010.

L. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth); 2010

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Compaction Density Test Reports.

1.05 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

B. When fill materials need to be stored on site, locate stockpiles where indicated by architect and/or construction manager.

1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
2. Prevent contamination.
3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 FILL MATERIALS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

PART 3 EXECUTION

3.01 EXAMINATION

3.02 TRENCHING

A. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

B. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.

C. Do not interfere with 45 degree bearing splay of foundations.

D. Cut trenches wide enough to allow inspection of installed utilities.

E. Hand trim excavations. Remove loose matter.

F. Remove excavated material that is unsuitable for re-use from site.

G. Remove excess excavated material from site.

3.03 PREPARATION FOR UTILITY PLACEMENT

A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.

B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.

C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.04 BACKFILLING

A. Backfill to contours and elevations indicated using unfrozen materials.

B. Employ a placement method that does not disturb or damage other work.

C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.

D. Maintain optimum moisture content of fill materials to attain required compaction density.

E. Slope grade away from building minimum 2 inches in 10 ft, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.

F. Correct areas that are over-excavated.

1. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.

G. Compaction Density Unless Otherwise Specified or Indicated:

H. Reshape and re-compact fills subjected to vehicular traffic.

3.05 BEDDING AND FILL AT SPECIFIC LOCATIONS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

3.06 FIELD QUALITY CONTROL

A. Perform compaction testing in accordance with recommendations contained in the geotechnical report.

B. See Section 01 4000 - Quality Requirements, for general requirements for field inspection and testing.

C. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, ASTM D2922, or ASTM D3017.

D. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D698 ("standard Proctor"), ASTM D1557 ("modified Proctor"), or AASHTO T 180.

E. If tests indicate work does not meet specified requirements, remove work, replace and retest.

END OF SECTION 31 2316.13

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Filling, backfilling, and compacting for building volume below grade.

B. Backfilling and compacting for utilities outside the building to utility main connections.

C. Filling holes, pits, and excavations generated as a result of removal (demolition) operations.

1.02 RELATED REQUIREMENTS

A. Perform all work in accordance with the Geotechnical Report.

B. Section 31 2200 - Grading: Removal and handling of soil to be re-used.

C. Section 31 2200 - Grading: Site grading.

D. Section 31 2316 - Excavation: Removal and handling of soil to be re-used.

E. Section 31 3700 - Riprap.

1.03 REFERENCE STANDARDS

A. Perform all work in accordance with the Geotechnical Report.

B. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 in.) Drop; American Association of State Highway and Transportation Officials; 2010.

C. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates; 2006.

D. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2012.

E. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 2007.

F. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN m/m3)); 2012.

G. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 2008.

H. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2011.

I. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by

Nuclear Methods (Shallow Depth); 2005.

J. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 2005.

K. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 2010.

L. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth); 2010.

1.04 DEFINITIONS

A. Finish Grade Elevations: Indicated on drawings.

B. Subgrade Elevations: Indicated on drawings.

1.05 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

B. When fill materials need to be stored on site, locate stockpiles where indicated.

1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
2. Prevent contamination.
3. Protect stockpiles from erosion and deterioration of materials.

C. Verify that survey bench marks and intended elevations for the Work are as indicated.

PART 2 PRODUCTS

2.01 FILL MATERIALS

A. Perform all work in accordance with the Geotechnical Report.

B. Concrete for Fill: Lean concrete.

C. Topsoil: See Section 31 2200.

PART 3 EXECUTION

3.01 EXAMINATION

A. Identify required lines, levels, contours, and datum locations.

B. See Section 31 2200 for additional requirements.

C. Verify subdrainage, dampproofing, or waterproofing installation has been inspected.

D. Verify structural ability of unsupported walls to support imposed loads by the fill.

E. Verify underground tanks are anchored to their own foundations to avoid flotation after backfilling.

3.02 PREPARATION

A. Scarify subgrade surface to a depth of 6 inches to identify soft spots.

B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.

C. Compact subgrade to density equal to or greater than requirements for subsequent fill material.

D. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

3.03 FILLING

A. Fill to contours and elevations indicated using unfrozen materials.

B. Fill up to subgrade elevations unless otherwise indicated.

C. Employ a placement method that does not disturb or damage other work.

D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.

E. Maintain optimum moisture content of fill materials to attain required compaction density.

F. Slope grade away from building minimum 2 inches in 10 ft, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.

G. Correct areas that are over-excavated.

1. Load-bearing foundation surfaces: Fill with concrete.
2. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.

H. Compaction Density Unless Otherwise Specified or Indicated:

I. Reshape and re-compact fills subjected to vehicular traffic.

3.04 FILL AT SPECIFIC LOCATIONS

A. Use general fill unless otherwise specified or indicated. See section 31-2300 Excavation, Backfill & Compaction for Structures.

3.05 FIELD QUALITY CONTROL

A. Perform compaction testing in accordance with recommendations contained in the geotechnical report.

B. See Section 01 4000 - Quality Requirements, for general requirements for field inspection and testing.

C. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, ASTM D2922, or ASTM D3017.

D. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D698 ("standard Proctor"), ASTM D1557 ("modified Proctor"), or AASHTO T 180.

E. If tests indicate work does not meet specified requirements, remove work, replace and retest.

3.06 CLEANING

A. Leave unused materials in a neat, compact stockpile.

B. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION 31 2323

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Excavating for building volume below grade, footings, pile caps, slabs-on-grade, paving, site structures, and utilities within the building.

B. Trenching for utilities outside the building to utility main connections.

1.02 RELATED REQUIREMENTS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. Section 31 2200 - Grading: Soil removal from surface of site.

C. Section 31 2200 - Grading: Grading.

D. Section 31 2323 - Fill: Fill materials, filling, and compacting.

1.03 PROJECT CONDITIONS

A. Verify that survey bench mark and intended elevations for the Work are as indicated.

B. Protect plants, lawns, rock outcroppings, and other features to remain.

C. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

PART 2 PRODUCTS

PART 3 EXECUTION

3.01 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. See Section 31 2200 for additional requirements.

3.02 EXCAVATING

A. Underpin adjacent structures that could be damaged by excavating work.

B. Excavate to accommodate new structures and construction operations.

C. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

D. Preparation for Piling Work: Excavate to working elevations. Coordinate special requirements for piling.

E. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.

F. Do not interfere with 45 degree bearing splay of foundations.

G. Cut utility trenches wide enough to allow inspection of installed utilities.

H. Hand trim excavations. Remove loose matter.

I. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 31 2323.

J. Grade top perimeter of excavation to prevent surface water from draining into excavation.

K. Remove excavated material that is unsuitable for re-use from site.

L. Stockpile excavated material to be re-used in area designated on site in accordance with Section 31 2200.

M. Remove excess excavated material from site.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for general requirements for field inspection and testing.

B. Provide for visual inspection of load-bearing excavated surfaces before placement of foundations.

3.04 PROTECTION

A. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.

B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

END OF SECTION 31 2316

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Riprap.

1.2 RELATED REQUIREMENTS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. Section 31 2323 - Fill: Aggregate requirements.

1.3 QUALITY ASSURANCE

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. Maintain one copy of each document on site.

PART 2 PRODUCTS

2.1 MATERIALS

A. Riprap: Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. Aggregate: Granular fill as specified in Section 31 2323.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not place riprap bags over frozen or spongy subgrade surfaces.

3.2 PLACEMENT

A. Place geotextile fabric over substrate, lap edges and ends.

B. Place riprap at culvert pipe ends, embankment slopes, and at locations specified in plans.

C. Place into position. Knead, ram, or pack filled bags to conform to contour of adjacent material and other bags previously placed.

D. Reference sheet C-501 for shape and dimensions. Reference sheet C-505 for required thickness.

E. Place rock evenly and carefully over bagged riprap to minimize voids, do not tear bag fabric, place bags and rock in one consistent operation to preclude disturbance or displacement of substrate.

F. After placement, spray with water to moisten the bagged mix. Maintain moist for 24 hours.

3.3 SCHEDULES

A. Culvert Pipe Ends: Bagged, placed one layer thick, 6 inch average thickness, concealed with topsoil fill.

B. Sloped Grade At Retaining Wall: Individual riprap units, 6 inch thickness; placed prior to finish topsoil.

END OF SECTION 31 3700

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NEW MEXICO
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COLORADO

Division 32 –
Exterior Improvements

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aggregate base course.

B. Paving aggregates.

1.02 RELATED REQUIREMENTS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. Section 31 2200 - Grading: Preparation of site for base course.

C. Section 31 2323 - Fill: Compacted fill under base course.

D. Section 32 1216 - Asphalt Paving: Binder and finish asphalt courses.

1.03 REFERENCE STANDARDS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses; American Association of State Highway and Transportation Officials; 1965 (2004).

C. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 in.) Drop; American Association of State Highway and Transportation Officials; 2010.

D. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates; 2006.

E. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2012.

F. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 2007.

G. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN m/m3)); 2012.

H. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 2008.

I. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2011.

J. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 2005.

K. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 2005.

L. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 2010.

1.04 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

B. When aggregate materials need to be stored on site, locate stockpiles where indicated.

1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
2. Prevent contamination.
3. Protect stockpiles from erosion and deterioration of materials.

C. Verify that survey bench marks and intended elevations for the Work are as indicated.

PART 2 PRODUCTS

2.01 MATERIALS

A. Provide material in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

2.02 SOURCE QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for general requirements for testing and analysis of aggregate materials.

B. Where aggregate materials are specified using ASTM D2487 classification, test and analyze samples for compliance before delivery to site.

C. If tests indicate materials do not meet specified requirements, change material and retest.

D. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify substrate has been inspected, gradients and elevations are correct, and is dry.

3.02 PREPARATION

A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.

B. Do not place aggregate on soft, muddy, or frozen surfaces.

3.03 INSTALLATION

A. Place aggregate in maximum 4 inch layers and roller compact to specified density.

B. Level and contour surfaces to elevations and gradients indicated.

C. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.

D. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.

E. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.04 CLEANING

A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

B. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION 32 1123

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aggregate base course.

B. Single course bituminous concrete paving.

C. Double course bituminous concrete paving.

D. Surface sealer.

1.02 RELATED REQUIREMENTS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. Section 31 2200 - Grading: Preparation of site for paving and base.

C. Section 31 2323 - Fill: Compacted subgrade for paving.

1.03 REFERENCE STANDARDS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. AI MS-2 - Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types; The Asphalt Institute; 1997.

C. AI MS-19 - A Basic Asphalt Emulsion Manual; The Asphalt Institute; Fourth Edition.

D. ASTM D946 - Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction; 2009a.

1.04 QUALITY ASSURANCE

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. Mixing Plant: Provide material in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

C. Obtain materials from same source throughout.

1.05 REGULATORY REQUIREMENTS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. Conform to applicable code for paving work on public property.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aggregate for Base Course: Provide material in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. Obtain materials from quarries located within a 500 mile radius of project site.

2.02 ASPHALT PAVING MIXES AND MIX DESIGN

A. Provide material in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

2.03 SUBMITTALS

A. Mix design

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that compacted subgrade is dry and ready to support paving and imposed loads.

B. Verify gradients and elevations of base are correct.

3.02 BASE COURSE

A. Place and compact base course.

3.03 PLACING ASPHALT PAVEMENT - SINGLE COURSE

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. Place asphalt within 24 hours of applying primer or tack coat.

C. Install gutter drainage grilles and frames in correct position and elevation.

D. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.

E. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

3.04 PLACING ASPHALT PAVEMENT - DOUBLE COURSE

A. Place asphalt binder course within 24 hours of applying primer or tack coat.

B. Place wearing course within two hours of placing and compacting binder course.

C. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.

D. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.05 SEAL COAT

A. Apply seal coat to surface course and asphalt curbs in accordance with AI MS-19.

3.06 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.

B. Compacted Thickness: Within 1/4 inch of specified or indicated thickness.

C. Variation from True Elevation: Within 1/2 inch.

3.07 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for general requirements for quality control.

B. Provide field inspection and testing. Take samples and perform tests in accordance with AI MS-2.

END OF SECTION 32 1216

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete sidewalks, stair steps, integral curbs, gutters, median barriers, parking areas, and roads.

1.02 RELATED REQUIREMENTS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. Section 31 2200 - Grading: Preparation of site for paving and base and preparation of subsoil at pavement perimeter for planting.

C. Section 31 2323 - Fill: Compacted subbase for paving.

D. Section 32 1123 - Aggregate Base Courses: Aggregate base course.

E. Section 32 1216 - Asphalt Paving: Asphalt wearing course.

F. Section 32 1443 – Cast Institu Paving System

G. Section 03 3000 – Cast in Place Concrete

1.03 REFERENCE STANDARDS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; American Concrete Institute International; 1991 (Reapproved 2002).

C. ACI 301 - Specifications for Structural Concrete for Buildings; American Concrete Institute International; 2010.

D. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International; 2000.

E. ACI 305R - Hot Weather Concreting; American Concrete Institute International; 2010.

F. ACI 306R - Cold Weather Concreting; American Concrete Institute International; 2010.

G. ASTM A185/A185M - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete; 2007.

H. ASTM A497/A497M - Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete; 2007.

I. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 2012.

J. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2011a.

K. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2012a.

L. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2012.

M. ASTM C150/C150M - Standard Specification for Portland Cement; 2012.

N. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2010b.

O. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete; 2010a.

P. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2011.

Q. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2012.

R. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2012.

S. ASTM C685/C685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing; 2011.

T. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (nonextruding and Resilient Bituminous Types); 2004 (Reapproved 2008).

U. ASTM D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction; 2004a (Reapproved 2008).

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Design Data: Indicate pavement thickness, designed concrete strength, reinforcement, and typical details.

PART 2 PRODUCTS

2.01 PAVING ASSEMBLIES

A. Comply with applicable requirements of ACI 301.

B. Design paving for parking and residential streets.

C. Concrete Sidewalks and Median Barrier: 3,000 psi, 28 day concrete. See plans for sections.

D. Parking Area Pavement: 4,000 psi, 28 day concrete. See plans for sections.

E. Parking Pavement: See section 32 1443 Cast Institu Paving System.

2.02 FORM MATERIALS

A. Form Materials: Conform to ACI 301.

B. Joint Filler: Preformed; non-extruding bituminous type (ASTM D1751) or sponge rubber or cork (ASTM D1752).

1. Thickness: 1/2 inch.

2.03 REINFORCEMENT

A. Reinforcing Steel and Welded Wire Reinforcement: Types specified in Section 03 3000.

2.04 CONCRETE MATERIALS

A. Obtain materials from quarries located within a 500 mile radius of project site.

B. Provide for 20% fly ash replacement of cement.

2.05 ACCESSORIES

A. Acid Etch Solution: Muriatic type mixed to a five percent solution.

2.06 CONCRETE MIX DESIGN

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

2.07 MIXING

A. On Project Site: Mix in drum type batch mixer, complying with ASTM C685/C94M. Mix each batch not less than 1-1/2 minutes and not more than 5 minutes.

B. Transit Mixers: Comply with ASTM C94/C94M.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.

B. Verify gradients and elevations of base are correct.

3.02 SUBBASE

A. See Section 32 1123 for construction of base course for work of this Section.

3.03 PREPARATION

A. Moisten base to minimize absorption of water from fresh concrete.

B. Coat surfaces of manhole frames with oil to prevent bond with concrete pavement.

C. Notify Architect minimum 24 hours prior to commencement of concreting operations.

3.04 FORMING

A. Place and secure forms to correct location, dimension, profile, and gradient.

B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.05 REINFORCEMENT

A. Place reinforcement at top of slabs-on-grade.

B. Interrupt reinforcement at contraction joints.

C. Place dowels to achieve pavement and curb alignment as detailed.

3.06 COLD AND HOT WEATHER CONCRETING

A. Follow recommendations of ACI 305R when concreting during hot weather.

B. Follow recommendations of ACI 306R when concreting during cold weather.

C. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

3.07 PLACING CONCRETE

A. Coordinate installation of snow melting components.

B. Place concrete in accordance with ACI 304R.

C. Do not place concrete when base surface is wet.

D. Place concrete using the slip form technique.

E. Ensure reinforcement, inserts, embedded parts, formed joints and expansion joints are not disturbed during concrete placement.

3.08 JOINTS

A. Align curb, gutter, and sidewalk joints.

B. Place 3/8 inch wide expansion joints at 20 foot intervals and to separate paving from vertical surfaces and other components and in pattern indicated.

1. Form joints with joint filler extending from bottom of pavement to within 1/2 inch of finished surface.
2. Secure to resist movement by wet concrete.

C. Provide scored joints:

1. At 3 feet intervals.
2. Between sidewalks and curbs.
3. Between curbs and pavement.

D. Provide keyed joints as indicated.

E. Saw cut contraction joints 3/16 inch wide at an optimum time after finishing. Cut 1/3 into depth of slab.

3.09 EXPOSED AGGREGATE

A. Wash scheduled concrete surfaces with acid etch solution exposing aggregate to match sample panel.

3.10 FINISHING

A. Area Paving: Light broom, texture perpendicular to pavement direction.

B. Sidewalk Paving: Light broom, texture perpendicular to direction of travel with troweled and radiused edge 1/4 inch radius.

C. Median Barrier: Light broom, texture perpendicular to direction of travel with troweled and radiused edge 1/4 inch radius.

D. Curbs and Gutters: Light broom, texture parallel to pavement direction.

E. Inclined Vehicular Ramps: Broomed perpendicular to slope.

F. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

3.11 TOLERANCES

A. Maximum Variation of Surface Flatness: 1/4 inch in 10 ft.

B. Maximum Variation From True Position: 1/4 inch.

3.12 PROTECTION

A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.

B. Do not permit pedestrian traffic over pavement for 7 days minimum after finishing.

END OF SECTION 32 1313

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Parking lot markings, including parking bays, crosswalks, arrows, handicapped symbols, and curb markings.

B. Roadway lane markings and crosswalk markings.

C. "No Parking" curb painting. Fire lane curb painting.

1.02 RELATED REQUIREMENTS

A. Section 32 1216 - Asphalt Paving.

B. Section 32 1313 - Concrete Paving.

1.03 REFERENCE STANDARDS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. FS TT-B-1325 - Beads (Glass Spheres); Retro-Reflective; Rev. D, 2007.

C. FS TT-P-1952 - Paint, Traffic Black, and Airfield Marking, Waterborne; Rev. E, 2007.

D. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association; current edition, www.paintinfo.com.

E. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; 2004.

F. FHWA MUTCD - Manual on Uniform Traffic Control Devices for Streets and Highways; U.S. Department of Transportation, Federal Highway Administration; http://mutcd.fhwa.dot.gov; current edition.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver paint in containers of at least 5 gallons accompanied by batch certificate.

B. Store products in manufacturer's unopened packaging until ready for installation.

C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

PART 2 PRODUCTS

2.01 MATERIALS

A. Line and Zone Marking Paint: MPI No. 97 Latex Traffic Marking Paint; color(s) as indicated.

1. Roadway Markings: As required by authorities having jurisdiction.
2. Parking Lots: Yellow.
3. Handicapped Symbols: Blue.
4. Fire lane curb as required by Fire Marshal.

B. Temporary Marking Tape: Preformed, reflective, pressure sensitive adhesive tape in color(s) required; Contractor is responsible for selection of material of sufficient durability as to perform satisfactorily during period for which its use is required.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of marking materials.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Clean surfaces thoroughly prior to installation.

1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.

D. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.

E. Establish survey control points to determine locations and dimensions of markings; provide templates to control paint application by type and color at necessary intervals.

F. Temporary Pavement Markings: When required or directed by Architect, apply temporary markings of the color(s), width(s) and length(s) as indicated or directed.

1. After temporary marking has served its purpose, remove temporary marking by carefully controlled sandblasting, approved grinding equipment, or other approved method so that surface to which the marking was applied will not be damaged.
2. At Contractor's option, temporary marking tape may used in lieu of temporary painted marking; remove unsatisfactory tape and replace with painted markings at no additional cost to Owner.

3.03 INSTALLATION

A. Begin pavement marking as soon as practicable after surface has been cleaned and dried.

B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F or more than 95 degrees F.

C. Apply in accordance with manufacturer's instructions using an experienced technician that is thoroughly familiar with equipment, materials, and marking layouts.

D. Comply with FHWA MUTCD manual (http://mutcd.fhwa.dot.gov) for details not shown.

E. Apply markings in locations determined by measurement from survey control points; preserve control points until after markings have been accepted.

F. Apply uniformly painted markings of color(s), lengths, and widths as indicated on the drawings true, sharp edges and ends.

1. Apply paint in one coat only.
2. Wet Film Thickness: 0.015 inch, minimum.
3. Width Tolerance: Plus or minus 1/8 inch.

G. Roadway Traffic Lanes: Use suitable mobile mechanical equipment that provides constant agitation of paint and travels at controlled speeds.

1. Conduct operations in such a manner that necessary traffic can move without hindrance.
2. Place warning signs at the beginning of the wet line, and at points well in advance of the marking equipment for alerting approaching traffic from both directions. Place small flags or other similarly effective small objects near freshly applied markings at frequent intervals to reduce crossing by traffic.
3. If paint does not dry within expected time, discontinue paint operations until cause of slow drying is determined and corrected.
4. Skip Markings: Synchronize one or more paint "guns" to automatically begin and cut off paint flow; make length of intervals as indicated.
5. Use hand application by pneumatic spray for application of paint in areas where a mobile paint applicator cannot be used.

H. Parking Lots: Apply parking space lines, entrance and exit arrows, painted curbs, and other markings indicated on drawings.

1. Mark the International Handicapped Symbol at indicated parking spaces.
2. Hand application by pneumatic spray is acceptable.

I. Symbols: Use a suitable template that will provide a pavement marking with true, sharp edges and ends, of the design and size indicated.

END OF SECTION 32 1723.13

SECTION 323113 - CHAIN LINK FENCES AND GATES - PSAE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Chain-Link Fences: Industrial

B. Related Sections include the following:

   1. Division 03 Section Cast-in-Place Concrete for concrete post concrete fill.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide chain-link fences and gates capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

   1. Minimum Post Size and Maximum Spacing for Wind Velocity Pressure: Determine based on mesh size and pattern specified, and on the following minimum design wind pressures and according to CLFMI WLG 2445:

      a. Wind Speed: 90 mph
      b. Fence Height: 6 feet
      c. Line Post Group: IA, ASTM F 1043, Schedule 40 steel pipe
      d. Wind Exposure Category: C

B. Lightning Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

1.4 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.

   1. Fence and gate posts, rails, and fittings.
   2. Chain-link fabric, reinforcements, and attachments.

B. Shop Drawings: Show locations of fences, gates, posts, rails, tension wires, details of extended posts, extension arms, gate swing, or other operation, hardware, and accessories. Indicate

materials, dimensions, sizes, weights, and finishes of components. Include plans, sections, details of post anchorage, attachment, bracing, and other required installation and operational clearances.

C. Qualification Data: For Installer.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed chain-link fences and gates similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.2 CHAIN-LINK FENCE FABRIC

A. General: Height four (4) feet. Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with ASTM A 392, CLFMI CLF 2445, and requirements indicated below:

1. Steel Wire Fabric: Metallic coated wire with a diameter of 0.148 inch

    a. Mesh Size: 2 inches
    b. Weight of Metallic (Zinc) Coating: ASTM A 392, Type II, Class 1, 1.2 oz./sq. ft. with zinc coating applied before weaving.
    c. Weight of Zn-5-Al-MM Aluminum-Mischmetal Alloy Coating: ASTM F 1345, Type III, Class 1, 0.60 oz./sq. ft. 2, 1.0 oz./sq. ft.
    d. Coat selvage ends of fabric that is metallic coated before the weaving process with manufacturer's standard clear protective coating.

2.3 INDUSTRIAL FENCE FRAMING

A. Posts and Rails: Comply with ASTM F 1043 for framing, ASTM F 1083 for Group IC round pipe, and the following:

1. Group: IA, round steel pipe, Schedule 40

2. Fence Height: 6 feet
3. Strength Requirement: Heavy industrial according to ASTM F 1043.
4. Post Diameter and Thickness: According to ASTM F 1043 ASTM F 1083.

    a. Top Rail: 1.66 inches
    b. Line Post: 1.875 by 1.63 inches
    c. End, Corner and Pull Post: 3.5 by 1.5 inches
    d. Swing Gate Post: According to ASTM F 900 2.375-inch diameter, 3.11-lb/ft. weight 4-inch diameter, 8.65-lb/ft.
    e. Horizontal-Slide Gate Post: According to ASTM F 1184.

        1) Openings up to 12 Feet: Steel post, 2.875-inch diameter, and 4.64-lb/ft. weight.
        2) Openings Wider Than 12 Feet : Steel post, 4-inch diameter, and 8.65-lb/ft. weight.
        3) Guide posts for Class 1 horizontal-slide gates equal the gate post height, 1 size smaller, but weight is not less than 3.11 lb/ft.; installed adjacent to gate post to permit gate to slide in space between.

5. Coating for Steel Framing:

    a. Metallic Coating:

        1) Type A, consisting of not less than minimum 2.0-oz./sq. ft. average zinc coating per ASTM A 123/A 123M or 4.0-oz./sq. ft. zinc coating per ASTM A 653/A 653M.

2.4 TENSION WIRE

A. General: Provide horizontal tension wire at the following locations:

1. Location: Extended along bottom of fence fabric.
2. Location: Extended along top of barbed wire arms and top of fence fabric for supporting barbed tape.

B. Metallic-Coated Steel Wire: 0.177-inch- diameter, marcelled tension wire complying with ASTM A 817, ASTM A 824, and the following:

1. Metallic Coating: Type II, zinc coated (galvanized) by hot-dip process, with the following minimum coating weight:

    a. Class 1: Not less than 0.8 oz./sq. ft. of uncoated wire surface.
    b. Matching chain-link fabric coating weight.

2.5 INDUSTRIAL SWING GATES

A. General: Comply with ASTM F 900 for single and double swing gate types.

1. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F 1043 and ASTM F 1083 for materials and protective coatings.

B. Frames and Bracing: Fabricate members from galvanized steel tubing with outside dimension and weight according to ASTM F 900 and the following:

1. Gate Fabric Height: 2 inches less than adjacent fence height
2. Leaf Width:
3. Frame Members:

    a. Tubular: 1.90 inches round

C. Frame Corner Construction:

1. Welded and 5/16-inch- diameter, adjustable truss rods for panels 5 feet wide or wider.

D. Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame 12 inches as required to attach barbed wire assemblies.

2.6 FITTINGS

A. General: Comply with ASTM F 626.

2.7 BARBED WIRE

A. Zinc-Coated Steel Barbed Wire: Comply with ASTM A 121, Standard Chain-Link Fence grade for the following two-strand barbed wire:

1. Standard Size and Construction: 0.099-inch- diameter line wire with 0.080-inch diameter, 2-point round barbs spaced not more than 4 inches o.c.

2.8 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.

2.9 FENCE GROUNDING

A. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.

1. Material above Finished Grade: Copper
2. Material on or below Finished Grade: Copper.
3. Bonding Jumpers: Braided copper tape, 1 inch wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

B. Connectors and Grounding Rods: Comply with UL 467.

1. Connectors for Below-Grade Use: Exothermic welded type.
2. Grounding Rods: Copper-clad steel.

    a. Size: 5/8 by 96 inches.

2.10 All fencing, gates and backstops for baseball field, softball field, batting gates, soccer field and tennis courts shall be in compliance with details shown on the plans.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance.

1. Do not begin installation before final grading is completed, unless otherwise permitted by Architect.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

A. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements specified.

1. Install fencing on established boundary lines inside property line.

3.4 CHAIN-LINK FENCE INSTALLATION

A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

B. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

    a. Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.

C. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 30 degrees or more.

D. Line Posts: Space line posts uniformly at 8 feet o.c.

E. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric 6 feet or higher, on fences with top rail and at 2/3 fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

F. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric.

1. Bottom Tension Wire: Install tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.

G. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

H. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 1 inch between finish grade or surface and bottom selvage, unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

I. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches o.c.

J. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at 1 end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts and top rail at 12 inches o.c. and to braces at 24 inches o.c.

K. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

L. Barbed Wire: Install barbed wire uniformly spaced angled toward security side of fence. Pull wire taut and install securely to extension arms and secure to end post or terminal arms.

M. Barbed Tape: Install barbed tape uniformly in configurations indicated and fasten securely to prevent movement or displacement.

N. Tennis Court Fencing: Construct tennis court fence according to ASTM F 969.

3.5 GROUNDING AND BONDING

A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:

1. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet

a. Gates and Other Fence Openings: Ground fence on each side of opening.

1) Bond metal gates to gate posts.
2) Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.

C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2, unless otherwise indicated.

D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the grounding location, including the following:

1. Each Barbed Wire Strand. Make grounding connections to barbed wire with wire-to-wire connectors designed for this purpose.
2. Each Barbed Tape Coil: Make grounding connections to barbed tape with connectors designed for this purpose.

E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

F. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

G. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor complying with NFPA 780.

3.6 ADJUSTING

A. Gate: Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

END OF SECTION 32 3113

SECTION 32 3120 – SECURITY FENCE AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Steel welded wire fences.
   2. Steel welded wire gates.
   3. Concrete post foundations.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.
   2. Section 03 3000 - Cast-In-Place Concrete.
   3. Section 31 2300 - Excavation and Fill.

1.2 REFERENCES

A. ASTM International (ASTM):
   1. A185/A185M - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
   2. A641/A641M - Standard Specifications for Zinc-Coated (Galvanized) Carbon Steel Wire.
   3. B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
   4. C94 - Standard Specification for Ready-Mixed Concrete.
   5. D3359 - Standard Practice for Measuring Adhesion by Tape Test.

B. Miami-Dade County
   1. High Velocity Hurricane Zone Certification.

1.3 SUBMITTALS

A. Submittals for Review:
   1. Shop Drawings: Indicate fence locations, post spacing, system components, and accessories.
   2. Product Data: Manufacturer's descriptive data.
   3. Samples:
      i. 12 x 12 inch fence panel samples.
      ii. 12 inch long post samples.
      iii. Cap and bracket samples.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Minimum 2 years documented experience in work of this Section.

B. Mockup:
   i. Size: Minimum 16 feet long x full height.
   ii. Show: Fence posts, panels, and accessories.
   iii. Locate where directed during construction.
   iv. Approved mockup may remain as part of the Work.

1.5 WARRANTIES

A. Furnish manufacturer's warranty providing coverage against corrosion of galvanized steel coatings and blistering or loosening of powder coatings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Contract Documents are based on products by Deacero S.A. DE C.V.
B. Substitutions: By prior approval under provisions of Division 01.

2.2 COMPONENTS

A. Fence Panels:
   1. Resistance welded steel wire mesh, ASTM A185/A185M, 6 gauge Class 1 galvanized steel wire per ASTM A641/A641M, 2 x 6 inch mesh, stiffened with horizontal V-shaped braces.
      i. Height: 4 feet & 6 feet, locations shown on drawings.
      ii. Wire breaking load: Minimum 80,000 PSI.
      iii. Weld shear strength: Minimum 1,050 pounds.

B. Posts:
   1. Galvanized steel tube, ASTM A513/A787, G60 coating class, 2¼ x 2¼ inches, 16 gauge.
   2. Length: To suit panel height and post mounting method.
   3. Post caps: Ultraviolet-protected plastic, sized to post dimensions, friction fit.
   4. Post bases: Steel plate bolted to bottom of posts, with four plated steel anchor bolts per base.

C. Post Brackets:
   1. Galvanized steel and powder coated, sized to post dimensions, with a 1¼" galvanized nut and bolt.

D. Gates:
   1. Custom built by design. Includes any specified hardware.

2.3 ACCESSORIES

A. None

2.4 FINISHES

A. Fence Panels and Posts:
   1. Polyester powder coated to approximately 4 mils thickness, free of both Triglycidyl Isocyanurate (TGIC) and Volatile Organic Compounds, Black color.
   2. Salt spray resistance: No rusting or blistering tested to ASTM B117 for 1000 hours.
   3. Adhesion: Tested to ASTM D3359, Method B.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fencing in accordance with manufacturer's instructions and approved Shop Drawings.
B. Drill post holes into undisturbed or compacted soil in accordance with local building codes.
      i. See drawings for additional mounting requirements at concrete walls.
C. Set posts with bottom hole in accordance with local building codes.
D. Place concrete around posts in accordance with local building codes.
E. Pour top of footings in accordance with local building codes.

3.2 INSTALLATION TOLERANCES

A. Maximum Variation from Plumb: ¼ inch in 10 feet.
B. Maximum Offset from True Position: 1 inch.

END OF SECTION

SECTION 328400 - LANDSCAPE IRRIGATION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The work consists of installing a complete underground irrigation system as shown on the Drawings and as specified hereafter. The Contractor shall furnish all labor, equipment, materials and permits necessary for the completion of the system, unless otherwise specified to be furnished by others. Unless otherwise specified or indicated on the Drawings, the construction of the irrigation system shall include the furnishing, installing and testing of all components pertinent to the system. The Contractor shall perform all trenching, excavating, boring, backfilling, compacting, concrete work, electrical work, welding, and any other work necessary for the completion of the irrigation system.

1.2 SITE INVESTIGATION

A. The Contractor shall examine related work and surfaces before starting the work of this section. The Contractor shall report to the Owner's Representative, in writing, conditions which will prevent the proper execution of irrigation installation. Deviations from Drawings and Specifications shall be executed only with the express permission of the Owner's Representative and at no cost to the Owner. If inadequacies or inappropriate design are found on the Drawings, they shall be promptly brought to the attention of the Owner's Representative in writing before proceeding with installation of the system.

1.3 CODES, RULES AND SAFETY ORDERS

A. All work and materials shall be in full accordance with the latest local rules and regulations of safety.

1.4 PROTECTION

A. The Contractor shall furnish and maintain all warning signs, shoring, barricades, red lanterns, and other protection devices, as required by the Safety Orders of the Division of Industrial Safety and local ordinances.

1.5 DEVIATIONS OF LAYOUT

A. Reasonable changes in the location of piping, valves or other irrigation components shown on the Drawings will be considered prior to installation. Deviations from specified locations must be approved by the Owner's Representative prior to installation. Any changes in location of irrigation components shall be effected at no cost to the Owner.

1.6 COORDINATION

A. The Contractor shall coordinate and cooperate with other contractors on site to ensure rapid and efficient completion of all contracted work.

1.7 SUBMITTALS

A. The Contractor shall prepare submittals providing manufacturer's specifications and product information on the following components:

Manual and automatic valves	Heads and emitters	Enclosures
Backflow preventer	Valve boxes	Drains
24 Volt wire	Wire splicing materials	Controller
Piping and tubing	PVC fittings	Filters
Joint materials	Detectable line marking tape	Grounding wire
PVC primer and cement	Threaded joint sealant or tape	Grounding rods
Quick couplers	Swing joints	

B. Each set of submittals shall be bound or provided electronically in PDF format, and shall be clearly labeled with the project name and date.

C. The Contractor shall not proceed with the irrigation system work until receiving approval of the irrigation submittals from the Owner's Representative.

1.8 AS-BUILTS

A. The Contractor shall provide and keep up to date a complete set of "As-Builts" which shall be corrected daily to show all changes in the location of heads, controllers, backflow preventers, valves, drains, meters, points of connection, pull boxes and wire splice boxes, pipe and wire routing and other changes that may have been made from the original Drawings and Specifications. All gate valves, manual drains, wire splice and automatic and manual valve locations shall be shown with actual measurements to reference points so they may be easily located in the field.

B. At the time of final acceptance, the Contractor shall furnish one electronic copy (on CD) and one paper copy of "As-Builts" prepared by a qualified draftsperson in AutoCAD format, showing the entire completed system as actually installed. This is the responsibility of the Contractor and shall not be construed to be the responsibility of any other party. This drawing shall be accurate and to scale. The symbols for valves, heads, and piping and other components shall be the same as originally shown on the Drawings. The legend shall be modified to designate any "record" changes. This "As-Built" shall be drawn on a project base sheet provided by the Owner's Representative. The final drawings shall be dated and clearly labeled "AS-BUILT".

1.9 CONTROLLER CHART

A. The Contractor shall provide two controller charts for each controller. Chart shall show the area covered by each automatic valve station on the controller with a different color used to show the area of coverage for each valve. Chart shall be a reduced drawing of the actual "As-Built" system. The size of the chart shall be the maximum size that the controller door will allow. If controller sequence is not legible when the drawing is reduced, drawing shall be enlarged to a size that is readable.

B. When completed and approved, chart shall be laminated with minimum 20 mils thick sheets. Chart shall be completed and approved prior to final observation and acceptance of the irrigation system. Contractor shall install one chart in each controller enclosure and shall provide one chart for each controller to the Owner's Representative.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials shall be new and without flaws or defects of any type and shall be the best of their class and kind. All materials shall have a minimum warranty of one year against material defects or defective workmanship.

B. All material shall be the brands and types noted on the Drawings or as specified herein, or approved equal (refer to Section 6.7 of the New Mexico Standard Specifications for Public Works Construction, 1979 Edition).

C. The irrigation system was designed around equipment manufactured by specific companies as a standard. Approved equal equipment by other manufacturers may be used only with the approval of the Owner's Representative. Request for approval of non-specified materials shall be submitted to the Owner's Representative a minimum of seven (7) days prior to the opening of bids. Submission of irrigation sprinkler heads for approval as equal shall only be considered if submitted heads match the precipitation rate, gallons per minute and spacing of specified sprinkler heads.

D. Irrigation components designated for use with recycled water shall be marked in accordance with the Uniform Plumbing Code.

2.3 PLASTIC PIPE AND FITTINGS

A. Plastic Pipe: Piping with a diameter of two inches (2") or less shall be Schedule 40 PVC and shall conform to ASTM D 1785. Piping with a diameter of two and one-half inches (2-1/2") or greater shall be Class 200 "O" ring gasket pipe, SDR 21 and shall conform to ASTM D 2241. All PVC pipe shall be continuously marked with identification of the manufacturer, type, class, and size, and shall be free of holes, foreign material, blisters, wrinkles, dents or sunburn.

B. PVC Fittings: Fittings on PVC lines shall be Schedule 40 PVC, Type 1, Cell Classification 12454 and shall comply with ASTM D 2466.

C. Threaded Nipples: All threaded PVC nipples shall be Schedule 80 molded PVC pipe. All galvanized nipples shall be Schedule 40 galvanized steel pipe.

2.4 VALVES AND VALVE BOXES

A. Valves: Valves for use in electrically controlled automatic control systems shall be diaphragm actuated and hydraulically operated solenoid valves as specified on the Drawings.

B. Isolation valves shall be as specified on the Drawings.

C. Valve Boxes: Valve boxes shall be as noted on the Drawings. Valve box colors shall be as follows:
   1. Green: Turf areas (potable water)
   2. Tan: Gravel mulch areas (potable water)

3. Purple: Reclaimed water

2.5 HEADS AND EMITTERS

A. Heads and emitters shall be as specified on the Drawings.

2.6 CONTROLLER

A. Controller shall be as specified on the Drawings.

2.7 BACKFLOW PREVENTER AND HEATED ENCLOSURE

A. The backflow prevention device and heated enclosure shall be as specified on the Drawings.

2.8 PRIMER, CEMENT AND THREADED JOINT SEALANT

A. Primer shall conform to ASTM F 656 and meet NSF. Cement shall be low VOC, NSF approved, and meet ASTM D 2564. Cement and primer shall be IPS Weld-On depending on size and schedule of pipe and fittings as follows:

Schedule 40 PVC Pipe and Fittings up to 6" Dia.:P-68 Primer and 705 Cement

Schedule 80 PVC Pipe and Fittings up to 4" Dia.:P-70 Primer and 705 Cement
Schedule 80 PVC Pipe and Fittings larger than 4" Dia.: P-70 Primer and 711 Cement

B. All threaded connections between metal to metal, PVC to metal**,** and PVC to PVC shall be made using Spears Blue 75 thread sealant or Polytetrafluoroethylene (PTFE) thread seal tape. PTFE thread seal tape shall comply with MIL-T-27730A Specifications shall have a minimum thickness of 3.5 mils and shall be 99% pure PTFE. Thread sealing compound shall not be used on threaded connections between sprinkler and nipple or bubbler and nipple. Thread sealant or PTFE tape shall be used in accordance with manufacturer's installation instructions.

C. All "O" ring gasket and pipe spigot ends shall be lubricated using the lubricant recommended or supplied by the pipe manufacturer. If the pipe manufacturer does not provide a lubricant for the pipe, use IPS Weld-on EZ Flush pipe lubricant, NSF approved.

2.9 WIRE

A. Wire for the 120 volt wiring shall be solid copper (or stranded copper in larger wire sizes), underground feeder for direct burial and PVC insulated. Size of wire shall be #12 AWG.

B. Wire for the 24 volt wiring shall be solid copper wire, PVC insulated, UL approved underground feeder wire for direct burial in ground. Common wires shall be #12, white, except as noted on Drawings. The control wires shall be #14 of any color other than white unless otherwise indicated on Drawings. The wire shall be supplied in either 500' or 2,500' rolls.

C. Wire Splicing Materials: All wire splices shall be made water-tight using 3M DBR/Y direct bury splice kit or approved equal.

D. Grounding wire, ground rods and wire clamps for controllers shall be as specified by the controller manufacturer.

E. Control wires shall be marked with the associated valve number with E-Z Coder WDR or equal wire marking tape at each valve, at the controller and at wire splices.

2.10 DETECTABLE LINE MARKING TAPE

A. Detectable line marking tape for irrigation main and lateral lines shall be manufactured by T.A. Christy Enterprises or approved equal and shall consist of a minimum 5.0 mil (0.0050") overall thickness; five-ply composition; ultra high molecular weight; 100% virgin polyethylene; acid, alkaline, and corrosion resistant.

B. The tape width shall be a minimum of 6".

C. Elongation properties shall be in accordance with ASTM D882-80A and shall be less than 150% at break.

D. Tensile strength shall be in accordance with ASTM D882-80A and shall be not less than 7800 PSI.

E. The tape shall have a minimum 20 gauge (0.0020") solid aluminum foil core, adhered to a 2.55 mil (0.00255") polyethylene backing.

F. Tape color and legend combination shall be in accordance with APWA requirements. For irrigation lines with potable water supply, the color shall be blue and the legend shall read "CAUTION: IRRIGATION LINE BURIED BELOW". For irrigation lines with non-potable water supply, the color shall be purple and the legend shall read "CAUTION: RECYCLED/RECLAIMED WATER LINE BURIED BELOW".

2.11 OTHER MISCELLANEOUS FITTINGS AND MATERIALS

A. All other miscellaneous fittings and materials shall be as specified on the Drawings.

PART 3 - EXECUTION

3.1 GENERAL

A. This section includes installation specifications for all items installed as a part of the irrigation system. Certain construction procedures or minor equipment installation procedures that are necessary for the proper installation of the system may have been omitted from these specifications. In any case, Contractor shall install all materials and equipment in a neat and workmanlike manner according to manufacturer's recommendations and specifications, local and state codes, as shown on the Drawings and as specified herein.

3.2 PRODUCT HANDLING

A. The Contractor shall be responsible for correct procedures in loading, unloading, staking,

transporting and handling all materials to be used in the system. The Contractor shall avoid rough handling which could affect the useful life of equipment. Pipe shall be handled in accordance with the manufacturer's recommendations on loading, unloading and storage.

3.3 POINT OF CONNECTION

A. Existing water main line locations shown on the Drawings are schematic. It shall be the Contractor's responsibility to pot hole and field check to determine actual locations as an incidental requisite to the construction contract.

B. The proposed controller location indicated on the Drawings is approximate. Actual location of the controller shall be determined by Owner's Representative in the field.

C. Where connections to existing pipe or stub out is required, the Contractor shall make necessary adjustments should pipe or stub out not be located exactly as shown, at no additional cost to the Owner.

3.4 STATIC PRESSURE TEST

A. The design pressure of the irrigation system is shown on the Drawings. Prior to start of construction of the irrigation system, the Contractor shall, in the presence of the Owner's Representative, provide a gauged test of available static pressure at the point of connection. In the event that the actual static pressure is significantly different (plus or minus 10 psi) than the design static pressure, the Contractor shall not proceed with the work until receiving written direction from the Owner's Representative.

3.5 EXCAVATION AND TRENCHING

A. The Contractor shall stake the location of each run of pipe and all sprinkler heads and valves prior to trenching. Each run of the system shall be approved by the Owner's Representative prior to installation.

B. Excavation and trenching for pipe lines shall be a true and straight line with the trench banks as nearly vertical as practical. The width of the trenches shall not be greater than necessary to permit proper joining, tamping, backfilling, bedding or any other installation procedures that may be necessary. Trench widths shall be wide enough to provide a minimum horizontal and vertical separation of 4" between pipes in the same trench.

C. In areas where trees are present, trench lines shall be adjusted on the site to eliminate any damage to tree roots.

D. Trench depths shall be sufficient to provide the specified pipe cover as described elsewhere in these Specifications or as noted on the Drawings. In rocky areas the trench depth and width shall be increased as needed to provide for a minimum of 6"of pipe bedding at bottom and sides of pipe.

E. Depth of Bury: Minimum cover over mainline and lateral piping shall be as noted on the Drawings.

3.6 PIPE AND FITTINGS INSTALLATION

A. Installation of plastic pipe and fittings shall be in accordance with ASTM D 2774, the manufacturer's recommendations and the procedures described in these Specifications.

B. Caution shall be exercised by the Contractor in handling, loading, unloading, and storing of PVC pipe and fittings. All PVC pipe shall be stored and transported in a vehicle with a bed long enough to allow the pipe to lie flat without subjecting it to undue bending or concentrated external load at any point. Pipe shall be protected from damage by exposure to sunlight. Any section of pipe that has been dented or damaged or in any other way found to be defective, either before or after laying shall be replaced with sound pipe at no cost to the Owner.

C. Before installation, the inside of the pipe shall be cleaned of all dirt and foreign matter and shall be kept in a clean condition during and after laying of pipe. When work is not in progress, open ends of pipe and fittings shall be secured closed so that no trench water, earth or other foreign substances will enter the pipe or fittings. Where pipe ends are left for future expansion or connections, they shall be valved and capped as directed on the Drawings.

D. All PVC pipe and fittings shall be assembled to permit the pipe or fittings to be jointed at the true parallel position of the fittings. Placement of pipe which cause excessive bending and stress on pipe and fittings will not be permitted. No excess piping or fittings shall be permitted in the installation of the system, as this may increase pressure loss or potential for blockage.

E. Before installing the pipe, all rocks over 1 inch diameter, rubbish and debris shall be removed from the trenches. If the adjacent soil is rocky, the trenches shall be bedded and filled with clean dirt or sand to provide a minimum of 6" clearance between the pipe and the native soil. Material used for pipe bedding and trench filling shall be approved by the Owner's Representative. The full length of each section of the pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, joints and couplings.

F. Pipe shall not be laid in water or when trench or weather conditions are unsuitable for the work. Any water which may be encountered or may accumulate in the trenches or excavation shall be pumped out or otherwise removed as necessary to keep the bottom of the trench or excavation free and clear of water during the progress of the work. Pipe shall not be laid when the temperature is 32 degrees F or below.

G. PVC pipe will expand or contract at the rate of +/- 3/8" per 100' per 10 degrees F change of temperature. Therefore, the pipe shall be installed in a manner to provide for expansion and contraction as recommended by the manufacturer.

H. The minimum horizontal and vertical clearance between lines in the same trench shall be 4".

I. After all piping, risers, valves, thrust blocks, etc., have been installed and partially backfilled as specified in other parts of these Specifications, the control valve shall be opened and a full head of water used to flush out the system. Caution shall be observed to provide for release of any entrapped air in the system. After the system is thoroughly flushed, risers shall be capped and the system pressure tested in accordance with the testing section of these Specifications. At the conclusion of the pressure test, the heads

shall be installed and the backfill operation completed.

3.7 SOLVENT WELDING PROCEDURE

A. All solvent weld joints shall be made in accordance with the solvent manufacturer's recommendations and ASTM D 2855.

B. PVC plastic pipe shall be squarely cut utilizing a miter box mounted hacksaw or PVC specialty saw with a blade of 18 or 24 teeth per inch.

C. Interior and exterior burrs shall be removed and the exterior shall be beveled to produce a 10-15 degree bevel.

D. Thoroughly clean the mating pipe end and the fitting socket with a clean, dry cloth.

E. Using a properly sized applicator (approximately ½ the diameter of the pipe), apply a light coating of primer to the inside of the fitting socket, then apply a thin coat to the outside of the pipe end. Apply a second, light coat of primer to the inside of the fitting socket taking care to avoid puddling of primer in fitting.

F. Apply a uniform coat of cement to the outside of the pipe end with a properly sized applicator (approximately ½ the diameter of the pipe).

G. In like manner, apply a thin coating of cement to the inside of the fitting socket.

H. Re-apply a light coat of cement to the outside of the pipe end and quickly insert it into the fitting to the full depth of the fitting socket, while rotating the pipe or fitting approximately ¼ turn to ensure even distribution of cement.

I. Hold in position for approximately 30 seconds.

J. Wipe off any excess solvent cement that forms as a bead around the outer shoulder.

K. Contractor shall not use an excessive amount of solvent cement that could cause burrs or obstructions to form on the inside of the pipe joint.

L. Solvent weld joints shall be allowed to cure for minimum 24 hours before pressure is applied to the system.

3.8 BACKFILLING

A. Upon completion of a particular section of the irrigation system, and after sufficient time has elapsed for the curing of solvent weld joints, partial backfilling shall begin, leaving all joints, risers and connections exposed for visual inspection during the hydrostatic testing. Only upon successful completion of the hydrostatic test shall the backfill operation be completed for any one particular section.

B. All backfill material shall be subject to approval by the Owner's Representative. Backfill material shall be free from rock, large stones, brush, sod, frozen material or other unsuitable substances that may damage pipe or compromise compaction during the backfilling operations.

C. In the event that the material from the excavation or trenching is found to be unsuitable for use in backfill by the Owner's Representative, it shall be removed from the site and properly disposed of by the Contractor at his own expense. The Contractor shall then, at no cost to the Owner, arrange for, purchase, and furnish suitable backfill material consisting of earth, loam, sandy clay, sand or other approved materials free of large clods of earth or sharp stones and capable of attaining the same relative density of the surrounding ground.

D. In rocky areas, the trench depth shall be 6" below the normal trench depth to allow for 6" of suitable backfill as padding for the pipe. In like manner, there shall be minimum 6" of suitable backfill on all sides of the pipe as padding against rock in the wall of the trench.

E. All mainline and lateral piping shall have detectable line marking tape installed in the trench six (6") inches above the pipe. After pipe is placed in trench and the first 6" layer of backfill is placed and compacted, the detectable marking tape shall be placed continuously in all trenches prior to completion of backfill operations.

F. Backfill shall be placed in horizontal layers not exceeding 6" in depth and shall be thoroughly tamped, or water compacted to near original density or so that no settling will result. Backfill shall be placed to the original ground level. If settlement of trenches occurs within one (1) year from date of completion, it shall be the Contractor's responsibility to refill trenches and re-seed, re-sod or re-install landscape mulch in the repaired areas.

3.9 SADDLE TAPS

A. No saddle taps shall be permitted unless approved by the Owner's Representative.

3.10 THRUST BLOCKS

A. Concrete thrust blocks shall be provided where necessary to resist system pressure, including at all direction changes, size changes, valves and terminations or at any other points of the system that will result in an unbalanced thrust line for equipment 2-1/2" and larger and as indicated on the Drawings. Thrust blocks shall not obstruct the outlets of fittings which are intended for future connections. Thrust blocks shall be poured against undisturbed earth and in accordance with the Drawings.

3.11 SLEEVED CROSSING

A. Unless otherwise noted on the Drawings, all piping installed under sidewalks, roadways, parking lots, etc., shall be sleeved in a Class 200 PVC pipe two (2) sizes larger than the pipe to be sleeved. Wire shall be placed in a separate sleeve from that of the pipe crossing and shall be Class 200 PVC minimum 2" size, or larger as required to accommodate the quantity of wire to be sleeved. Ends of sleeves shall be sealed with duct tape after installation of wire or piping.

3.12 HEAD INSTALLATION (ROTORS AND POP UPS)

A. Heads shall be of the type and make specified and shall be installed as shown on the Drawings. Heads shall be installed with a 4" space between the edge of the head and

curbs, walks, walls, driveways, building walls, etc. Heads shall be installed in the vertical position and backfilled and compacted to 80% modified Proctor.

B. Head spacing shall not exceed the spacing shown on the Drawings and shall be in the location and configuration as shown on the Drawings. Contractor shall verify turf area dimension while staking head location. Heads shall be spaced to achieve uniform coverage.

C. After all piping and risers are in place and connected and before installation of the heads, all control valves for a given section shall be fully opened and a full head of water shall be used to flush out the system. If water pressure without the heads installed is not sufficient to provide adequate water flow from end risers, the Contractor shall cap off enough heads closest to the water source to provide adequate flushing of the end riser assemblies.

3.13 CONTROLLER INSTALLATION

A. The controller location is indicated on the Drawings. The Contractor shall familiarize himself with the requirements of making the power connections at the locations noted (120 volt supply to the controller) and shall include in his price for the-irrigation system, the cost to complete this portion of the work.

B. The controller shall be mounted and wired according to the manufacturer's recommended procedures and as specified herein and on the Drawings.

C. Unless otherwise indicated in the Drawings, the Contractor shall direct-wire the 120 volt power supply to the controller.

D. Remote control valves shall be connected to controller in the numerical sequences as shown on the Drawings or as directed by the Owner’s Representative.

E. Controllers shall be grounded as specified by the manufacturer and as indicated on the Drawings.

3.14 AUTOMATIC CONTROL VALVE INSTALLATION

A. Automatic control valves shall be of the type and size indicated on the Drawings. Installation shall be according to these Specifications, the Drawings and the manufacturer's recommendations.

B. The valve boxes shall be of the size and type as shown on the Drawings.

C. Valve wire splices shall be waterproofed using 3M DBR/Y direct bury splice kit or approved equal. The Contractor shall provide a 36" wire expansion coil to facilitate raising splices to ground level without cutting wires.

3.15 24 VOLT CONTROL VALVE WIRING

A. Wire installation procedures shall conform to local codes.

B. The Contractor shall install the 24 volt control valve wiring in the same trench as the irrigation mainline. All wires shall be laid below the pipe. In no case shall the wire be

laid on top of the pipe. The wires shall be laid loose in the trench and taped together at 10'-0" intervals. When trenches used for piping are not appropriate for routing wire, Contractor shall install wire in a separate trench at 18" bury depth.

C. Wire splices, other than at valve box locations, shall be kept to a minimum and if needed shall be made only at common splice points and placed in a wire splice box, Applied Engineering 9” round valve box with flush cover or equal. Wire splices shall be waterproofed using 3M DBR/Y direct bury splice kit or approved equal.

D. At control wire splices, the Contractor shall provide a 36" wire expansion coil to facilitate raising splices to ground level without cutting wires.

E. Continual wire shall be one color and in no case shall wires of different colors be spliced together.

F. All 24 volt wiring shall be installed in PVC conduit when inside a building. All 24 volt wiring installed on exterior building walls shall be installed in metal conduit.

3.16 120 VOLT CONTROLLER POWER WIRING

A. The Contractor shall familiarize himself with the work required to complete this portion of the installation. All 120 volt wiring shall be installed in accordance with local electrical codes. The 120 volt service shall consist of one (1) black and one (1) white wire. The neutral wire shall be bonded.

B. The 120 volt power shall be supplied to the controller location and the backflow preventer location by a licensed electrician.

3.17 TESTING

A. Upon completion of the irrigation system's mainline, the entire mainline shall be tested with the Owner’s Representative present, for a one hour period at 100 psi, unless otherwise noted. Prior to testing, the mainline shall be partially backfilled, leaving all joints and connections exposed for visual inspection. All dirt shall be flushed from the system and the line filled with water to remove air. The mainline shall be brought to static pressure. A pressure gauge and temporary valve shall be installed at the end of the mainline to permit air pressure to be applied to the main. A pressure of 100 psi shall be retained for a one hour period. Any leaks occurring during the one hour pressure test shall be repaired and the system retested until the system passes the test.

B. Upon completion of the lateral piping sections, each lateral system shall be pressure tested, with the Owner’s Representative present for one hour at 100 psi. On systems using flex nipples or swing joints, the lateral system shall be tested prior to installation of the flex nipples or swing joints. Prior to testing, the lateral lines shall be partially backfilled leaving all joints and connections exposed for visual inspection. All air and dirt shall be flushed from the system and all open fittings shall be capped. The testing procedure shall be the same as used for the main line. Any leaks occurring during the hydrostatic test shall be repaired and the system retested until the system passes the test. If after one hour 100 psi pressure has been retained, the heads shall be installed, and the backfill operation completed.

C. The Contractor shall be responsible for payment of construction observations for retesting of any lines or system components that fail initial pressure or performance test. Costs shall include the time of the observer at the observer's standard rate, travel time and travel expenses.

3.18 ADJUSTING OF SYSTEM

A. After completion of testing and installation, the Contractor shall adjust all valves for the proper operating pressure and adjust all heads for uniform coverage and even flow. Contractor shall wire the controller to have station numbers correspond with valve numbers indicated on the Drawings or as directed by the Owner's Representative. The valve number shall be indicated on the controller panel for each station. Contractor shall program the controller to provide optimum system performance.

3.20 CLEAN UP

A. The Contractor shall continuously keep a neat and orderly area in which he is installing the system. Disposal of rubbish and waste material resulting from the installation shall be continual. Upon completion of the system, the Contractor shall remove from the Owner's property at his own expense, all temporary structures, rubbish, waste material, tools and equipment resulting from or used in the installation of the system.

3.21 PROTECTION OF EXISTING UTILITIES

A. The Contractor shall be responsible for locating all existing cables, conduits, piping, and any other utilities or structures that may be encountered either above or below ground. All necessary precautions shall be taken by the Contractor to prevent any damage to the existing utilities and improvements. In the event that such damage should occur from his operations, the Contractor shall repair or replace damaged utilities to their original condition at no expense to the Owner.

3.22 ROCK

A. If the Contractor encounters rock or other unfavorable trenching conditions, no additional compensation will be paid. When material from the excavation or trenching is unsuitable for use as backfill, additional backfill material suitable for this purpose shall be brought in at the expense of the Contractor. It shall be the Contractor's responsibility to remove and dispose of all unsuitable materials removed from the trench that cannot be used in the backfill operation.

3.23 FINAL ACCEPTANCE

A. When the Contractor is satisfied that the system is operating properly, that it is balanced and adjusted and that all work and clean-up is completed, he shall issue a notice of completion to the Owner's Representative requesting a final observation. The Owner's Representative will respond to the notice of completion and shall appear with the Owner for an observation of the project. At that time the Contractor shall demonstrate the operation of each system in its entirety. In reviewing the work, no allowance for deviation from the original Drawings and Specifications will be made unless prior approval has been obtained.

B. Any inconsistency to the Specifications or the Drawings will be noted by the Owner's Representative and a written copy of required corrections shall be given to the Contractor. The Contractor shall complete all corrections in a timely manner and then shall issue a request to the Owner's Representative for an inspection of corrected work. Final acceptance will not occur until correction of all items work is complete.

3.24 OPERATIONAL INSTRUCTION

A. After the system has been tested and accepted, the Contractor shall instruct the Owner's Representative on the operation and maintenance of the system.

B. The Contractor shall provide the Owner with two (2) keys for each of the following:

1. manual isolation valves
2. manual drain valves
3. valve boxes
4. controller enclosure
5. backflow preventer enclosure
6. quick couplers
7. any locking assembly in need of key access

C. The Contractor shall provide the Owner with two copies of a Maintenance Manual bound in a three ring binder. The maintenance manual shall include copies of the approved submittals, operation manuals and manufacturer's warranties on all irrigation products.

3.25 SYSTEM MAINTENANCE AND GUARANTEE

A. Maintenance of the irrigation system shall begin immediately following the installation of the system and shall continue until the entire project is accepted. Maintenance shall include repair of defects or damages, adjustments and fine tuning of the system, and repairs of damages resulting from vandalism, erosion, weather, and the like.

B. For a period of one (1) year from final acceptance of the entire project, the Contractor shall promptly furnish and install, without cost to Owner, any and all parts or materials which prove defective in material or workmanship. Damage to the landscape or other property due to irrigation system line breaks shall be repaired and brought to original condition by the Contractor at no expense to the Owner.

C. In the fall, at the Owner's request, the Contractor shall drain the system, and otherwise prepare the system for winter. In the spring, at the Owner's request, the Contractor shall reactivate the system, repair any defects or damage and adjust the system. As these services are performed, the Contractor shall instruct the Owner.

D. For a period of one (1) year from final acceptance of the system, the Contractor shall repair any settlement of trenches by one of the following methods as directed by the Owner's Representative.

1. Turf areas:
    a. Bring to grade by top-dressing (raking topsoil into the grass).
    b. Bring to grade with planting soil mixture and install seed mix to

match existing turf.

3. Sod areas or tree/shrub planting areas: Remove existing sod or mulch. Fill depression with planting soil mixture, and replace with new sod or mulch to match existing.

Repair by any of the above methods shall result in a smooth, level area.

3.26 OBSERVATIONS

A. The following observations shall be the minimum required observations during the course of construction. Additional observations shall be made at any time at the discretion of the Owner's Representative. It shall be the responsibility of the Contractor to notify the Owner's Representative, in writing, 48 hours in advance of each required observation. The sequence of required observations shall not be changed from the sequence listed below. The Contractor shall not proceed with work of the next sequence without written approval of the work of the previous sequence. The Contractor shall attach a copy of the written observation approvals to all applications for payment.

1. Observe staked locations of mainline, valves, laterals and heads.
2. Observe installation and pressure test of mainline.
3. Observe 24 volt control wire installation and ensure that existing controller operates all valve zones properly.
4. Observe installation and pressure test of automatic valves and lateral lines prior to installation of flex nipples, swing joints, and heads.
5. Observe head placement, coverage and operating pressure prior to planting.
6. Observe at final project review.
7. Observe 11 months after final project acceptance.

END OF SECTION

SECTION 329223 - SODDING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work under this section consists of preparing all areas indicated on the Drawings for grass sodding according to the specifications and furnishing and installing all sod, fertilizer and soil amendments as specified herein.

1.2 REFERENCE STANDARDS

A. ASPA (American Sod Producers Association) - Guideline Specifications to Sodding.

1.3 SUBMITTALS

A. Furnish soil test results for any fill that has been imported into landscape areas prior to start of landscape construction.

B. Furnish supplier literature and chemical analysis (or botanical analysis for sod) of the following prior to construction:

1. Organic amendments
2. Chemical fertilizer
3. Soil conditioner
4. Sod

C. Furnish the following the same day materials are delivered to the project site:

1. Delivery tickets indicating quantity of material delivered for:
   a. Organic amendments
   b. Chemical fertilizer
   c. Soil conditioner

PART 2 - PRODUCTS

2.1 SOD

A. Sod shall be as specified on the Drawings. A sample of sod and a written submittal of the seed mix shall be submitted a minimum of fifteen (15) days prior to laying of sod. Sod shall be vigorous, well rooted healthy turf free from disease, insect pests, weeds, other grasses, stones and other harmful or deleterious matter.

B. Sod shall be cut by an approved mechanical sod cutter to a thickness of not less than 1" or more than 2". Sod pieces shall be cut a maximum of 18" wide. Handling of sod shall be done in a manner that will prevent tearing, breaking, drying or any other damage. Sod shall be installed in place on the site not more than 24 hours after cutting.

C. Sod shall have no more than 2" of loose thatch. The sod shall be dense enough so that an entire strip can be lifted by the top 10% without breaking.

2.2 FERTILIZER

A. Fertilizer shall be a granular form fertilizer with a guaranteed analysis of 18-24-12 or as specified in the recommendations of the soil test results.

2.3 ORGANIC AMENDMENTS

Organic amendment shall consist of:

A. 70% by volume, organic compost. Compost shall be a well decomposed, stable, weed free organic matter source. It shall be derived from agricultural, food, or industrial residuals, biosolids, yard trimmings, source separated or mixed solid waste. The product shall contain no substances toxic to plants and shall be reasonably free (<1% by dry weight) of man-made foreign matter. The compost will possess no objectionable odors and shall not resemble the raw material from which it was derived. The product shall meet the standards established through the US Composting Council's Seal of Testing Assurance Program." Compost to be screened to 1/2" minus, pH within a range of 6.0-8.5. Electrical conductivity (EC) of compost not to exceed 10 mmhos/cm. Percentage of organic matter shall be in the range of 30-65%, tested by simple combustion. Compost provider shall be permitted through the NMED.

B. 30% by volume, clean, screened, white vitric tuff, screened to pass #40 mesh.

D. Components to be homogeneously mixed, in ten cubic yard batches to provide a uniform product, free from weed seeds, sticks, rocks, or other deleterious material.

F. Each Delivery shall have a load ticket. The load ticket shall list:
Type of Mixture
Source of Mixture.
Approximate volume of load.
Date of delivery of loading.
Name of individual representing the source.

Ticket shall be collected and provided to the Owner's Representative.

2.4 SOIL CONDITIONER

A. Granulated 90% sulfur

2.5 ADDITIONAL AMENDMENTS

A. Gypsum

PART 3 - EXECUTION

3.1 SOD BED PREPARATION

A. Prior to start of soil preparation soil shall be cleared of rocks and lumps of 1" diameter and greater, vegetation and debris to a minimum depth of 12". Finish grade shall be established and approved as meeting the requirements of the grading plan.

B. Rip all areas to be sodded to a depth of 12”. Apply a uniform 2" layer of organic amendment, 4 lbs. of fertilizer per each 1000 square feet, 10 pounds soil conditioner per each 1000 square feet, and 1 lb gypsum per each 10000 square feet to the entire area to be sodded. After application of organic amendment, fertilizer, soil conditioner, and gypsum all areas to be sodded shall be thoroughly rototilled at cross directions to a minimum depth of 6 inches. After rototilling is complete at cross directions, drag to an even grade, then roll for firmness.

C. If the Contractor has imported fill into a landscape area, the Contractor shall coordinate with the Owner’s Representative to have samples of the fill submitted to an independent soil testing laboratory for nutritional analysis. The cost of the soil testing shall be paid by the Contractor. If recommended by the soil test laboratory, the Contractor shall revise the specified fertilizer, organic amendments and soil conditioner to be in accordance with the recommendations specified on the soil test report. If recommended by the soil test laboratory, the Contractor shall provide and incorporate additional fertilizers and soil amendments into the fill in the landscape area in accordance with the recommendations specified on the soil test report.

3.2 SOD INSTALLATION

A. Before laying sod, the finish grade shall be brought to a firm, even surface, free from stones and lumps 1” diameter and greater, and shaped to provide drainage in accordance with the Drawings. The finish grade shall be inspected and approved by the Owner’s Representative prior to laying any sod.

B. Lay sod over moistened soil lightly raking the soil ahead of each sod strip. Sod shall be laid perpendicular to the direction of slope and shall have staggered joints. Pieces shall be fitted together tightly so that no joint is visible, and sod tamped firmly and evenly by hand. Stake as required on slopes.

C. After sodding is completed, all sod areas shall be rolled. Rolling shall be done in two directions perpendicular to each other. After rolling, repair and reroll any areas where depressions or other irregularities occur.

D. Water all sodded areas immediately after final rolling with fine spray to a depth of 4". Irrigate by means of the automatic underground irrigation system all sodded areas as often as necessary to promote healthy grass growth. Mowing during the maintenance period shall be scheduled so that the grass is maintained at a height no shorter than two (2) inches and no greater than three (3) inches.

E. Contractor shall not lay sod during freezing temperatures or over frozen soil. If sod cannot be installed due to freezing temperatures and/or frozen soil, Contractor shall postpone installation of sod until the temperature and soil conditions meet the requirements of these specifications.

3.3 MAINTENANCE AND PROTECTION

A. Maintenance and protection shall continue until the entire project is accepted. Acceptance shall occur after all sod is well rooted.

B. Maintenance shall include watering, weeding, cultivating, fertilizing, removal of dead

material and debris, and such other operations as may be necessary for the health of the sod and the general appearance of the landscaped areas. Protection shall include care or replacement of the sod from damages resulting from trespass, erosion (including watering), weather, vandalism, disease and the like.

3.4 WARRANTY

A. Sod shall be guaranteed to be in a live, healthy, and normal growing condition through twelve months from the date of final acceptance by the Owner's Representative. The Contractor shall not be held responsible for replacement of sod lost through vandalism and/or other destruction after contract final acceptance.

B. The Contractor shall monitor the condition of the sod at regular intervals during the warranty period to verify that the sod is receiving proper maintenance. Frequency of monitoring visits shall be as required to ensure proper maintenance. If at any time during the warranty period the Contractor should encounter at the site conditions unfavorable to the health of the sod, he shall notify the Owner and Owner's Representative of such in writing. Inadequate or improper maintenance by the Owner during the warranty period will not relieve the Contractor of his warranty obligation, unless such improper maintenance continues beyond the date the Contractor has notified the Owner and Owner's Representative.

C. Sod that is dead or in an unhealthy, impaired growth condition during the warranty period shall be removed and replaced by the Contractor. Replacement material shall match quality and species of the sod originally specified and shall be approved by the Owner's Representative prior to installation. Sod replaced during the first six months of the warranty period shall be under warranty until the end of the warranty period. Sod replaced after the first six months of the warranty period shall-be under warranty for six months after the replanting date.

3.5 OBSERVATIONS

A. The following observations shall be the minimum required inspections during the course of construction. Additional observations shall be made at any time at the discretion of the Owner's Representative.

B. It shall be the responsibility of the Contractor to notify the Owner's Representative, in writing, 48 hours in advance of each required observation.

C. The sequence of required observations shall not be changed from the sequence listed below. The Contractor shall not proceed with work of the next sequence without written approval of the work of the previous sequence.

1. Automatic irrigation system shall be installed, tested, and approved.
2. Each phase of soil preparation shall be observed in process.
3. Finish grade shall be observed.
4. Sod shall be observed prior to laying.
5. Sod shall be observed after installation.
6. Sod shall be observed at final project review.
7. Sod shall be observed 11 months after final project acceptance.

END OF SECTION

SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Work under this section consists of the planting of trees, shrubs, and ground covers, including the furnishing of all labor, equipment, and materials and performing all work in connection therewith in accordance with the Drawings and Specifications.

1.2 PLANT NAMES

A. The botanic and common names used for the plants called for on the Drawings are generally in conformity with the approved names given in Standardized Plant Names, 1980 Edition, published by The American Joint Committee on Horticultural Nomenclature. The names of varieties not included therein are generally in conformity with the names accepted in the nursery trade.

1.3 PLANT MATERIAL SUBSTITUTIONS

A. Plant material substitutions shall not be made without the written permission of the Owner's Representative. The use of materials differing in kind, quality or size from that specified shall be allowed only after the Owner's Representative is convinced that all means of obtaining the specified materials have been exhausted. At the time bids are submitted, the Contractor is assumed to have located the materials necessary to complete the job as specified. All requests for substitutions shall be submitted no later than five (5) working days prior to the opening of bids.

1.4 SUBMITTALS

A. Furnish samples of the following prior to construction:

1. Mulch

B. Furnish supplier literature and chemical analysis of the following prior to construction:

1. Backfill amendment
2. Soil conditioner
3. Filter fabric

C. Furnish delivery tickets the same day materials are delivered to the project site for the following:

1. Backfill amendment
2. Soil conditioner

PART 2 - MATERIALS

2.1 PLANT MATERIALS

A. A complete plant list, including quantities, sizes and other requirements is shown on the Drawings. In the event that a discrepancy occurs between quantities of plants indicated in the plant schedule and on the planting plan, the plant quantities indicated on the planting plan shall govern.

2.2 PLANT MATERIAL QUALITY

A. Plant material quality, size and condition shall be in accordance with American Standard for Nursery Stock, 1986, as published by the Committee on Horticultural Standards of the American Association of Nurserymen, Inc., the Drawings, and the following requirements:

1. All plants shall be typical of their species or variety. All plants shall have normal, well developed branches and vigorous root systems. They shall be sound, healthy, vigorous, and free from defects, disfiguring knots, abrasions of the bark, sunscale injuries, plant diseases, insect eggs, borers, and all other forms of infections.

2. Unless otherwise stated on the Drawings or approved by the Owner's Representative, all plants shall be nursery grown and shall be tagged with nursery labels indicating species and variety.

3. Container grown plant material shall have been grown in its delivery container for not less than six (6) months, but for not more than two (2) years. Any rootbound material will not be accepted.

4. Multi-stem: All countable stems, in aggregate, shall average the size specified. To be considered a stem, the division of the trunk shall be no more than six inches from ground level.

5. Balled and burlapped plant material shall have a solid ball of earth of minimum specified size held in place securely by burlap and stout twine or rope. Light poultry binding is acceptable. Stout wire or wire baskets are acceptable only as a temporary means for securing burlap until tree is in place. Broken or loose balls will be rejected.

6. Unless specifically noted on the Drawings, all trees shall have a single trunk that is straight and free of "dog legs", "crooks", "Y-crotches", or other disfiguring shapes. The central leader of all trees shall not have been pruned. Trees with double leaders are not acceptable.

7. All plant material shall have a uniform shape around its complete circumference. Plant material with irregular branching patterns or with branching patterns more highly developed on one side than on other sides will not be accepted.

8. All plant material shall be reviewed by the Owner's Representative at the Contractor's yard or at a wholesale nursery of the Contractor's choice prior to delivery to the job site. All material shall then be reviewed after planting.

10. The Contractor shall mark each plant intended for use on the project with an identifying tag prior to the Owner's Representative's review of the plants.

11. The Owner's Representative shall be the judge of the quality and acceptability of all plant material. All rejected material shall be immediately removed from the site and replaced with acceptable material at no additional cost to the Owner.

2.3 PLANTING SOIL MIXTURE

A. Planting Soil Mixture shall be a mixture of one part backfill amendment to two parts existing soil.

The backfill amendment shall consist of:

1. 70% by volume, organic compost. Compost shall be a well decomposed, stable, weed free organic matter source. It shall be derived from agricultural, food, or industrial residuals, biosolids, yard trimmings, source separated or mixed solid waste. The product shall contain no substances toxic to plants and shall be reasonably free (<1% by dry weight) of man-made foreign matter. The compost will possess no objectionable odors and shall not resemble the raw material from which it was derived. The product shall meet the standards established through the US Composting Council's Seal of Testing Assurance Program." Compost to be screened to 1/2" minus, pH within a range of 6.0-8.5. Electrical conductivity (EC) of compost not to exceed 10 mmhos/cm. Percentage of organic matter shall be in the range of 30-65%, tested by simple combustion. Compost provider shall be permitted with the NMED.

2. 30% by volume clean, screened, white vitric tuff, graded to 3/16" x 5/16".

2. Components to be homogeneously mixed, in ten cubic yard batches to provide a uniform product, free from weed seeds, sticks, rocks, or other deleterious material.

3. Each delivery shall have a load ticket. The load ticket shall list:
Type of Mixture
Source of Mixture.
Approximate volume of load.
Date of delivery or loading.
Name of individual representing the source.
Ticket shall be collected and provided to the Owner's Representative.

2.4 SOIL CONDITIONER

A. Shall be granulated 90% sulfur.

2.5 MULCH

A. Mulch shall be as specified on the Drawings.

PART 3 - EXECUTION

3.1 PLANTING OPERATIONS

A. Prior to planting operations, landscape areas shall be cleared of rocks and lumps greater than 1" diameter, vegetation, and debris to a minimum depth of 12” and finish grading shall be complete and accepted by the Owner’s Representative. Planting operations shall be performed only during favorable weather conditions in accordance with accepted practice.

B. In any one day, only those plant materials intended to be planted that day shall be delivered to the project site. Unless otherwise approved by Owner’s Representative, all plant materials shall be located where shown on the Drawings except when adjustments due to field conditions are required. The location of all trees and shrubs shall be staked by the Contractor and reviewed by the Owner’s Representative prior to installation. Tree locations shall be represented by using 1" x 2" x 12" wood stakes or colored flags. The name of the tree shall be indicated on the stake or flag so it is readily identified. Shrub locations shall be determined by colored flags or by placement of containerized plant material.

3.2 PLANTING

A. Planting and backfilling shall be performed in accordance with accepted nursery practice, the Drawings, and the following requirements:

1. The Contractor shall take care when backfilling planters to provide adequate compaction of the fill material in order to prevent settling.

2. Prepare all planting pits and install plants as shown on Drawings. Plants shall be set plumb and straight.

3. Remove wire basket, wood box, plastic, twine, and/or rope prior to backfill. Remove burlap except from bottom of root ball prior to backfill.

4. Backfill for planting pits shall consist of the specified planting soil mixture and .10 pounds soil conditioner per cubic foot of backfill. The plant shall be positioned in the hole, and backfilled. The backfilling shall be completed, and material tamped. When pit is nearly filled, water thoroughly and allow water to soak away. If settling of backfill occurs after watering, add more backfill to bring to finish grade.

5. After completion of planting, trees shall be pruned at the direction of the Owner’s Representative.

3.3 MULCH

A. Mulch shall be completed as indicated on the Drawings.

B. Avoid placing mulch against the trunk or stem of any plant material.

3.4 MAINTENANCE AND PROTECTION

A. Maintenance and protection of trees, shrubs, and ground covers shall begin immediately following the installation of each plant and shall continue until the entire project is accepted. Maintenance shall include watering, weeding, cultivating, removal and replacement of dead plant material, removal of debris, resetting of trees to upright positions, restoration of earth basins, and such other operations as may be necessary for the health of the planted stock and the general appearance of the landscaped areas. Maintenance and protection shall include repair of damage to plants and replacement of severely damaged plants resulting from trespass, erosion (including erosion from application of irrigation water), weather, vandalism, disease or other condition or action.

3.5 WARRANTY

A. All plant materials shall be guaranteed to be in a live, healthy, and normal growing condition from the date of final project acceptance through one twelve month period. The Contractor shall not be held responsible for replacement of plants and materials lost through vandalism and/or other destruction after final project acceptance.

B. The Contractor shall monitor the condition of the landscape at regular intervals during the warranty period to verify that the landscape is receiving proper maintenance. Frequency of monitoring visits shall be as required to ensure proper maintenance. If at any time during the warranty period the Contractor should encounter at the site conditions unfavorable to the health of the planted stock, he shall notify the Owner and Owner's Representative of such in writing. Inadequate or improper maintenance by the Owner during the warranty period will not relieve the Contractor of his warranty obligation, unless such improper maintenance continues beyond the date the Contractor has notified the Owner and Owner's Representative.

C. Plant materials that are dead or in an unhealthy, impaired growth condition during the warranty period shall be removed and replaced by the Contractor as directed by the Owner's Representative at no additional cost to the Owner. Replacement material shall be of equal quality, size, and species as that which is being replaced and shall be approved by the Owner's Representative prior to planting. Plants replaced during the first six months of the warranty period shall be under warranty until the end of the warranty period. Plants replaced after the first six months of the warranty period shall be under warranty for six months after the replanting date.

3.6 REVIEWS

A. The following observations shall be the minimum required observations during the course of construction. Additional observations shall be made at any time at the discretion of the Owner's Representative. It shall be the responsibility of the Contractor to notify the Owner's Representative, in writing, 48 hours in advance of each required observation. The sequence of required observations shall not be changed from the sequence listed below. The Contractor shall not proceed with work of the next sequence without written
approval of the work of the previous sequence.

1. Review plant material at Contractor's yard or wholesale nursery prior to delivery to job site.
2. Review staked locations of plant material prior to planting.

3. Review of planting operations.
4. Review at final project completion.
5. Review 11 months after final project acceptance.

END OF SECTION

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NEW MEXICO
TEXAS
COLORADO

Division 33 –
Utilities

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Monolithic concrete manholes with masonry transition to lid frame, covers, anchorage, and accessories.

B. Modular precast concrete manhole sections with tongue-and-groove joints with masonry transition to lid frame, covers, anchorage, and accessories.

C. Monolithic FRP manholes with transition to lid frame, covers, anchorage, and accessories.

D. Masonry manhole sections with masonry transition to lid frame, covers, anchorage, and accessories.

1.02 RELATED REQUIREMENTS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. Section 03 3000 - Cast-in-Place Concrete.

C. Section 04 2000 - Unit Masonry: Masonry units and mortar and grout.

1.03 REFERENCE STANDARDS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. ACI 530/530.1/ERTA - Building Code Requirements and Specification for Masonry Structures; American Concrete Institute International; 2009.

C. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2003 (Reapproved 2008).

D. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2009.

E. ASTM C55 - Standard Specification for Concrete Brick; 2009.

F. ASTM C62 - Standard Specification for Building Brick (Solid Masonry Units Made From Clay or Shale); 2010.

G. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections; 2009.

H. ASTM C478M - Standard Specification for Precast Reinforced Concrete Manhole Sections [Metric]; 2009.

I. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals; 2008.

J. ASTM C923M - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals [Metric]; 2008b.

K. ASTM D3753 - Standard Specification for Glass-Fiber-Reinforced Polyester Manholes and Wetwells; 2005.

1.04 FIELD CONDITIONS

A. Cold and Hot Weather Requirements: Comply with requirements of ACI 530/530.1/ERTA or applicable building code, whichever is more stringent.

PART 2 PRODUCTS

2.01 MATERIALS

A. Manhole Sections: Reinforced precast concrete in accordance with ASTM C478 (ASTM C478M), with resilient connectors complying with ASTM C923 (ASTM C923M).

B. Manhole Sections: ASTM D3753, glass-fiber reinforced polyester with integral steps.

C. Concrete: As specified in Section 03 3000.

D. Mortar and Grout: As specified in Section 04 2000, Type S.

E. Concrete Reinforcement: As specified in Section 03 3000.

2.02 CONFIGURATION

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify items provided by other sections of Work are properly sized and located.

B. Verify that built-in items are in proper location, and ready for roughing into Work.

C. Verify excavation for manholes is correct.

3.02 PREPARATION

A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.

3.03 MANHOLES

A. Place concrete base pad, trowel top surface level.

B. Place manhole sections plumb and level, trim to correct elevations, anchor to base pad.

C. Form and place manhole cylinder plumb and level, to correct dimensions and elevations. As work progresses, build in fabricated metal items.

D. Cut and fit for pipe.

E. Grout base of shaft sections to achieve slope to exit piping. Trowel smooth. Contour as required.

F. Coordinate with other sections of work to provide correct size, shape, and location.

3.04 MASONRY WORK

A. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.

B. Lay masonry units in running bond. Course one unit and one mortar joint to equal 8 inches.

C. Form concave mortar joints.

D. Lay masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.

E. Install joint reinforcement 16 inches on center.

F. Place joint reinforcement in first and second horizontal joints above base pad and below lid frame opening.

END OF SECTION 33 0513

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe and fittings for site water lines including domestic water lines and fire water lines.

B. Valves, Fire hydrants, and Domestic water hydrants.

1.02 RELATED REQUIREMENTS

A. Perform all work in accordance with the American Public Works Association New Mexico Chapter, New Mexico Standard Specifications for Public Works Construction (Latest Edition).

B. Section 03 3000 - Cast-in-Place Concrete: Concrete for thrust restraints.

C. Section 31 2316 - Excavation: Excavating of trenches.

D. Section 31 2323 - Fill: Bedding and backfilling.

E. Section 31 2316.13 - Trenching: Excavating, bedding, and backfilling.

F. Section 33 0513 - Manholes and Structures.

G. Section 03 3000 - Cast-in-Place Concrete: Concrete for thrust restraints.

H. Section 09 9000 - Painting and Coating.

1.03 REFERENCES

A. Perform all work in accordance with the American Public Works Association New Mexico Chapter, New Mexico Standard Specifications for Public Works Construction (Latest Edition).

B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2012 (ANSI B16.18).

C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2010).

D. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2009.

E. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2012.

F. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2009.

G. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2006.

H. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings; 1996 (Reapproved 2010).

I. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter; 2012.

J. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals; 1998 (Reapproved 2011).

K. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society; 2011 and errata.

L. AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water; American Water Works Association; 2008 (ANSI/AWWA C104/A21.4).

M. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; American Water Works Association; 2010 (ANSI/AWWA C105/A21.5).

N. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; American Water Works Association; 2007 (ANSI/AWWA C111/A21.11).

O. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water; American Water Works Association; 2009 (ANSI/AWWA C151/A21.51).

P. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service; American Water Works Association; 2009.

Q. AWWA C502 - Dry Barrel Fire Hydrants; American Water Works Association; 2005 (ANSI/AWWA C502/C502a).

R. AWWA C504 - Rubber Seated Butterfly Valves; American Water Works Association; 2010.

S. AWWA C508 - Swing-Check Valves for Waterworks Service, 2 In. (50 mm) Through 24 In. (600 mm) NPS; American Water Works Association; 2011 (ANSI/AWWA C508).

T. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service; American Water Works Association; 2009 (ANSI/AWWA C509).

U. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances; American Water Works Association; 2010 (ANSI/AWWA C600).

V. AWWA C606 - Grooved and Shouldered Joints; American Water Works Association; 2011.

W. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Distribution; American Water Works Association; 2008 (ANSI/AWWA C900/C900a).

X. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service; American Water Works Association; 2008.

Y. UL 246 - Hydrants for Fire-Protection Service; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

1.05 QUALITY ASSURANCE

A. Perform all work in accordance with the American Public Works Association New Mexico Chapter, New Mexico Standard Specifications for Public Works Construction (Latest Edition).

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers with labeling in place.

PART 2 PRODUCTS

2.01 WATER PIPE

A. Provide material in accordance with the American Public Works Association New Mexico Chapter, New Mexico Standard Specifications for Public Works Construction (Latest Edition).

2.02 VALVES

A. Provide valves in accordance with the American Public Works Association New Mexico Chapter, New Mexico Standard Specifications for Public Works Construction (Latest Edition).

B. Valves: Manufacturer's name and pressure rating marked on valve body.

2.03 HYDRANTS

A. Provide hydrants in accordance with the American Public Works Association New Mexico Chapter, New Mexico Standard Specifications for Public Works Construction (Latest Edition).

B. Hydrants: AWWA C502, UL 246, dry barrel type.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that building service connection and municipal utility water main size, location, and invert are as indicated.

3.02 PREPARATION

A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare pipe connections to equipment with flanges or unions.

3.03 TRENCHING

A. See the sections on excavation and fill for additional requirements.

B. See Section 31 2316.13 for additional requirements.

C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.04 INSTALLATION - PIPE

A. Route pipe in straight line.

B. Install pipe to allow for expansion and contraction without stressing pipe or joints.

C. Slope water pipe and position drains at low points.

3.05 INSTALLATION - VALVES AND HYDRANTS

A. Set valves on solid bearing.

B. Center and plumb valve box over valve. Set box cover flush with finished grade.

C. Set hydrants plumb; locate pumper nozzle perpendicular to and facing roadway.

D. Set hydrants to grade, with nozzles at least 20 inches above ground.

E. Locate control valve 4 inches away from hydrant.

F. Provide a drainage pit 36 inches square by 24 inches deep filled with 2 inches washed gravel. Encase elbow of hydrant in gravel to 6 inches above drain opening. Do not connect drain opening to sewer.

G. Paint hydrants in accordance with Section 09 9000.

3.06 SERVICE CONNECTIONS

A. Provide water service to utility company requirements with reduced pressure backflow preventer and water meter with by-pass valves and sand strainer.

B. Provide sleeve in retaining wall for service main. Support with reinforced concrete bridge. Calk enlarged sleeve watertight.

C. Anchor service main to interior surface of foundation wall.

D. Provide 18 gage galvanized sheet metal sleeve surrounding service main to 6 inches above floor and 6 feet minimum below grade. Size for 2 inches minimum of glass fiber insulation stuffing.

END OF SECTION 33 1116

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Disinfection of site domestic water lines and site fire water lines specified in Section 33 1116.

B. Disinfection of building domestic water piping specified in Section 22 1005.

C. Disinfection of water storage tanks.

D. Testing and reporting results.

1.02 RELATED REQUIREMENTS

A. Perform all work in accordance with the American Public Works Association New Mexico Chapter, New Mexico Standard Specifications for Public Works Construction (Latest Edition).

B. Section 33 1116 - Site Water Utility Distribution Piping.

1.03 PRICE AND PAYMENT PROCEDURES

A. See Section 01 2200 - Unit Prices, for additional unit price requirements.

B. Disinfection: By the linear foot. Includes preparing, disinfecting, testing, and reporting.

1.04 REFERENCE STANDARDS

A. Perform all work in accordance with the American Public Works Association New Mexico Chapter, New Mexico Standard Specifications for Public Works Construction (Latest Edition).

B. AWWA B300 - Hypochlorites; American Water Works Association; 2011 (ANSI/AWWA B300).

C. AWWA B301 - Liquid Chlorine; American Water Works Association; 2010 (ANSI/AWWA B301).

D. AWWA B302 - Ammonium Sulfate; American Water Works Association; 2010 (ANSI/AWWA B302).

E. AWWA B303 - Sodium Chlorite; American Water Works Association; 2010.

F. AWWA C651 - Disinfecting Water Mains; American Water Works Association; 2005 (ANSI/AWWA C651).

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Test Reports: Indicate results comparative to specified requirements.

C. Disinfection report:

1. Type and form of disinfectant used.
2. Date and time of disinfectant injection start and time of completion.
3. Test locations.
4. Initial and 24 hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
5. Date and time of flushing start and completion.
6. Disinfectant residual after flushing in ppm for each outlet tested.

D. Bacteriological report:

1. Date issued, project name, and testing laboratory name, address, and telephone number.
2. Time and date of water sample collection.
3. Name of person collecting samples.
4. Test locations.
5. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
6. Coliform bacteria test results for each outlet tested.
7. Certification that water conforms, or fails to conform, to bacterial standards of _____.

PART 2 PRODUCTS

PART 3 EXECUTION

3.01 DISINFECTION

A. Use method prescribed by the applicable state or local codes, or health authority or water purveyor having jurisdiction, or in the absence of any of these follow AWWA C651.

B. Provide and attach equipment required to perform the work.

C. Inject treatment disinfectant into piping system.

D. Maintain disinfectant in system for 24 hours.

E. Flush, circulate, and clean until required cleanliness is achieved; use municipal domestic water.

F. Replace permanent system devices removed for disinfection.

END OF SECTION 33 1300

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sanitary sewerage drainage piping, fittings, and accessories.

B. Connection of building sanitary drainage system to municipal sewers.

C. Cleanout Access.

1.02 RELATED REQUIREMENTS

A. Perform all work in accordance with the American Public Works Association New Mexico Chapter, New Mexico Standard Specifications for Public Works Construction (Latest Edition).

B. Section 03 3000 - Cast-in-Place Concrete: Concrete for cleanout base pad construction.

C. Section 31 2316 - Excavation: Excavating of trenches.

D. Section 31 2316.13 - Trenching: Excavating, bedding, and backfilling.

E. Section 31 2323 - Fill: Bedding and backfilling.

F. Section 31 2316.13 - Trenching: Excavating, bedding, and backfilling.

G. Section 33 0513 - Manholes and Structures.

H. Section 03 3000 - Cast-in-Place Concrete: Concrete for cleanout base pad construction.

1.03 REFERENCE STANDARDS

A. Perform all work in accordance with the American Public Works Association New Mexico Chapter, New Mexico Standard Specifications for Public Works Construction (Latest Edition).

B. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2009.

C. ASTM A746 - Standard Specification for Ductile Iron Gravity Sewer Pipe; 2009.

D. ASTM C12 - Standard Practice for Installing Vitrified Clay Pipe Lines; 2009.

E. ASTM C14 - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe; 2011.

F. ASTM C14M - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe [Metric]; 2011.

G. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe; 2012a.

H. ASTM C76M - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric); 2012a.

I. ASTM C425 - Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings; 2004 (Reapproved 2009).

J. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets; 2012.

K. ASTM C443M - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric); 2011.

L. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2011.

M. ASTM C700 - Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated; 2011.

N. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2012.

O. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2011.

P. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2011.

Q. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings; 2005.

R. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2008.

S. AWWA C111/A21.11 - American National Standard for Rubber Gasket Joints For Cast Iron and Ductile Iron Pressure Pipe and Fittings; 2007. (ANSI/AWWA C111/A21.11)

1.04 DEFINITIONS

A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.05 REGULATORY REQUIREMENTS

A. Perform all work in accordance with the American Public Works Association New Mexico Chapter, New Mexico Standard Specifications for Public Works Construction (Latest Edition).

1.06 PROJECT CONDITIONS

A. Coordinate the Work with termination of sanitary sewer connection outside building, connection to municipal sewer utility service, and trenching.

PART 2 PRODUCTS

2.01 SEWER PIPE MATERIALS

A. Provide material in accordance with the American Public Works Association New Mexico Chapter, New Mexico Standard Specifications for Public Works Construction (Latest Edition).

B. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

2.02 PIPE ACCESSORIES

A. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Sewer Service " in large letters.

2.03 BEDDING AND COVER MATERIALS

A. Pipe Bedding Material: As specified in Section 31 2316.13.

B. Pipe Cover Material: As specified in Section 31 2316.13.

PART 3 EXECUTION

3.01 GENERAL

A. Perform work in accordance with applicable code(s).

3.02 TRENCHING

A. See Section 31 2316.13 for additional requirements.

B. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.03 INSTALLATION - PIPE

A. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch in 10 feet.

B. Connect to building sanitary sewer outlet, through installed sleeves.

C. Install trace wire 6 inches above top of pipe; coordinate with Section 31 2316.13.

END OF SECTION 33 3111

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Storm drainage piping, fittings, and accessories.

B. Connection of drainage system to municipal sewers.

C. Catch basins, Plant area drains, Paved area drainage, Site surface drainage, Detention tank, and Detention basin.

1.02 RELATED REQUIREMENTS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. Section 03 3000 - Cast-in-Place Concrete: Concrete for cleanout base pad construction.

C. Section 31 2316 - Excavation: Excavating of trenches.

D. Section 31 2316.13 - Trenching: Excavating, bedding, and backfilling.

E. Section 31 2323 - Fill: Bedding and backfilling.

F. Section 31 2316.13 - Trenching: Excavating, bedding, and backfilling.

G. Section 33 0513 - Manholes and Structures.

H. Section 03 3000 - Cast-in-Place Concrete: Concrete for cleanout base pad construction.

1.03 REFERENCE STANDARDS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. AASHTO M 36 - Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains; American Association of State Highway and Transportation Officials; 2003.

C. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2009.

D. ASTM C12 - Standard Practice for Installing Vitrified Clay Pipe Lines; 2009.

E. ASTM C14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe; 2007.

F. ASTM C14M - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe [Metric]; 2007.

G. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe; 2011.

H. ASTM C76M - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe [Metric]; 2011.

I. ASTM C425 - Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings; 2004 (Reapproved 2009).

J. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets; 2010.

K. ASTM C443M - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets (Metric); 2010.

L. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2009a.

M. ASTM C700 - Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated; 2011.

N. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2006.

O. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2011.

P. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2011.

Q. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings; 2005.

R. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2008.

1.04 DEFINITIONS

A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

1.06 REGULATORY REQUIREMENTS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. Conform to applicable code for materials and installation of the Work of this section.

1.07 PROJECT CONDITIONS

A. Coordinate the Work with termination of storm sewer connection outside building, trenching, connection to foundation drainage system.

PART 2 PRODUCTS

2.01 SEWER PIPE MATERIALS

A. Provide material in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

2.02 PIPE ACCESSORIES

A. Provide all fittings, joints, and other required appurtenances in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Storm Sewer Service " in large letters.

2.03 CATCH BASIN, CLEANOUT, AND AREA DRAIN COMPONENTS

A. Provide in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

2.04 BEDDING AND COVER MATERIALS

A. Bedding: As specified in Section 31 2316.13.

B. Cover: As specified in Section 31 2316.13.

PART 3 EXECUTION

3.01 TRENCHING

A. See Section 31 2316.13 for additional requirements.

B. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.02 INSTALLATION – PIPE

A. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch in 10 feet.

B. Connect to building storm drainage system, foundation drainage system, and utility/municipal sewer system.

C. Install continuous trace wire 6 inches above top of pipe; coordinate with Section 31 2316.13.

3.03 INSTALLATION - CATCH BASINS AND CLEANOUTS

A. Form bottom of excavation clean and smooth to correct elevation.

B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.

C. Establish elevations and pipe inverts for inlets and outlets as indicated.

D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

END OF SECTION 33 4111

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe culvert, joints and accessories.

B. Bedding and slope protection at pipe end.

1.02 RELATED REQUIREMENTS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. Section 31 2316 - Excavation: Excavating of trenches.

C. Section 31 2323 - Fill: Bedding and backfilling.

D. Section 31 3700 - Riprap.

1.03 REFERENCE STANDARDS

A. Perform all work in accordance with the 2019 Edition of the New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Design.

B. ASTM A929/A929M - Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe; 2001 (Reapproved 2007).

C. ASTM C14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe; 2007.

D. ASTM C14M - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe [Metric]; 2007.

E. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe; 2011.

F. ASTM C76M - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric); 2011.

G. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets; 2010.

H. ASTM C443M - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets (Metric); 2010.

PART 2 PRODUCTS

2.01 STEEL CULVERT PIPE

A. Provide material in accordance with the 2019 Edition of the New Mexico State

Department of Transportation Standard Specifications for Highway and Bridge Design.

B. Corrugated Steel Pipe: Fabricated of ASTM A929/A929M galvanized steel sheet:

C. Coupling Bands: Galvanized steel, 0.052 inches thick x 10 inches wide; connected with two neoprene "O" ring gaskets and two galvanized steel bolts.

2.02 BEDDING AND COVER MATERIALS

A. Bedding: As specified in Section 31 2316.13.

B. Cover: As specified in Section 31 2316.13.

END OF SECTION