REQUEST FOR PROPOSAL
(FOR CONSTRUCTION CONTRACT)

SOLICITATION NO. W9128F25RA043

POWER INDEPENDENCE, MISSION CONTROL STATION
PN CRWU223006 (FY27)

BUCKLEY SFB, COLORADO

JUNE 2025

US Army Corps of Engineers ®
Omaha District

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SECTION 26 20 00

ELECTRICAL DISTRIBUTION SYSTEM

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PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering

ASTM INTERNATIONAL (ASTM)

ASTM B1	(2013) Standard Specification for Hard-Drawn Copper Wire
ASTM B8	(2023) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2023) National Electrical Safety Code
IEEE C57.12.01	(2020) General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid-Cast and/or Resin-Encapsulated Windings
IEEE C57.12.51	(2019) IEEE Guide for Mechanical Interchangeability of Ventilated Dry-Type Transformers
IEEE C57.12.80	(2010) Standard Terminology for Power and Distribution Transformers
IEEE C57.12.91	(2011) Standard Test Code for Dry-Type Distribution and Power Transformers
IEEE C57.98	(2011) Guide for Transformer Impulse Tests

IEEE C57.124	(1991; R 2002) Recommended Practice for the Detection of Partial Discharge and the Measurement of Apparent Charge in Dry-Type Transformers

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA NEIS 1	(2015) Standard for Good Workmanship in Electrical Construction

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C80.1	(2020) American National Standard for Electrical Rigid Steel Conduit (ERSC)
ANSI C80.3	(2020) American National Standard for Electrical Metallic Tubing (EMT)
ANSI C80.5	(2020) American National Standard for Electrical Rigid Aluminum Conduit
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA BU 1.1	(2010) General Instructions for Proper Handling, Installation, Operation and Maintenance of Busway Rated 600 V or Less
NEMA FU 1	(2012) Low Voltage Cartridge Fuses
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA KS 1	(2013) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)
NEMA MG 1	(2021) Motors and Generators
NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase

	Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors
NEMA RN 1	(2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA ST 20	(2014) Dry-Type Transformers for General Applications
NEMA TC 2	(2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 3	(2021) Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing
NEMA VE 1	(2017) Metal Cable Tray Systems
NEMA WD 1	(1999; R 2020) Standard for General Color Requirements for Wiring Devices
NEMA WD 6	(2021) Wiring Devices Dimensions Specifications
NEMA Z535.4	(2011; R 2017) Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code
NFPA 70E	(2024) Standard for Electrical Safety in the Workplace
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-568.1	(2020e) Commercial Building Telecommunications Infrastructure Standard
TIA-569	(2019e; Add 1 2022) Telecommunications Pathways and Spaces
TIA-607	(2019d) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 431	Energy Efficiency Program for Certain Commercial and Industrial Equipment
29 CFR 1910.147	The Control of Hazardous Energy (Lock Out/Tag Out)

29 CFR 1910.303	Electrical, General

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-520-01	(2015; with Change 2, 2021) Interior Electrical Systems
UFC 3-540-01	(2014; with Change 2, 2019) Engine-Driven Generator Systems for Prime and Standby Power Applications

UL SOLUTIONS (UL)

UL 1	(2005; Reprint Jan 2022) UL Standard for Safety Flexible Metal Conduit
UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 6A	(2008; Reprint Mar 2021) UL Standard for Safety Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel
UL 20	(2018; Reprint Jan 2021) UL Standard for Safety General-Use Snap Switches
UL 44	(2018; Reprint May 2021) UL Standard for Safety Thermoset-Insulated Wires and Cables
UL 50	(2024) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 67	(2018; Reprint Jul 2020) UL Standard for Safety Panelboards
UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 248-4	(2010; Reprint Apr 2019) Low-Voltage Fuses - Part 4: Class CC Fuses
UL 248-8	(2011; Reprint Aug 2020) Low-Voltage Fuses - Part 8: Class J Fuses
UL 248-10	(2011; Reprint Aug 2020) Low-Voltage Fuses - Part 10: Class L Fuses
UL 248-12	(2011; Reprint Aug 2020) Low Voltage Fuses - Part 12: Class R Fuses
UL 248-15	(2018) Low-Voltage Fuses - Part 15: Class T Fuses
UL 360	(2013; Reprint Aug 2021) UL Standard for Safety Liquid-Tight Flexible Metal Conduit

UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 486A-486B	(2018; Reprint May 2021) UL Standard for Safety Wire Connectors
UL 486C	(2018; Reprint May 2021) UL Standard for Safety Splicing Wire Connectors
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 506	(2017; Reprint Jan 2022) UL Standard for Safety Specialty Transformers
UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 510	(2020; Dec 2022) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514A	(2013; Reprint Jun 2022) UL Standard for Safety Metallic Outlet Boxes
UL 514B	(2012; Reprint May 2020) Conduit, Tubing and Cable Fittings
UL 514C	(2014; Reprint Feb 2020) UL Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 651	(2011; Reprint May 2022) UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL 674	(2022) UL Standard for Safety Electric Motors and Generators for Use in Hazardous (Classified) Locations
UL 698A	(2018; Rev 2019) UL Standard for Safety Industrial Control Panels Relating to Hazardous (Classified) Locations
UL 797	(2007; Reprint Mar 2021) UL Standard for Safety Electrical Metallic Tubing -- Steel
UL 854	(2020; Reprint Jan 2022) Standard for Service-Entrance Cables
UL 857	(2009; Reprint Apr 2021) UL Standard for Safety Busways
UL 869A	(2006; Reprint Jun 2020) Reference Standard for Service Equipment
UL 870	(2016; Reprint Mar 2019) UL Standard for Safety Wireways, Auxiliary Gutters, and

	Associated Fittings
UL 877	(1993) Standard for Safety Circuit Breakers and Circuit-Breaker Enclosures for Use in Hazardous (Classified) Locations
UL 886	(1994) Standard for Safety Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations
UL 943	(2016; Reprint Sep 2023) UL Standard for Safety Ground-Fault Circuit-Interrupters
UL 984	(1996; Reprint Sep 2005) Hermetic Refrigerant Motor-Compressors
UL 1008	(2022) UL Standard for Safety Transfer Switch Equipment
UL 1010	(2006) Standard for Safety Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations
UL 1063	(2017; Reprint Jun 2022) UL Standard for Safety Machine-Tool Wires and Cables
UL 1203	(2013; Reprint Apr 2022) UL Standard for Safety Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations
UL 1242	(2006; Reprint Apr 2022) UL Standard for Safety Electrical Intermediate Metal Conduit -- Steel
UL 1283	(2017; Reprint Feb 2024) UL Standard for Safety Electromagnetic Interference Filters
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices
UL 1561	(2011; Reprint Jun 2015) Dry-Type General Purpose and Power Transformers
UL 1569	(2018) UL Standard for Safety Metal-Clad Cables
UL 1660	(2019; Reprint Jan 2022) Liquid-Tight Flexible Nonmetallic Conduit
UL 1699	(2017; Reprint Feb 2022) UL Standard for Safety Arc-Fault Circuit-Interrupters
UL 4248-1	(2022) UL Standard for Safety Fuseholders - Part 1: General Requirements
UL 4248-12	(2018; Reprint Feb 2022) UL Standard for Safety Fuseholders - Part 12: Class R

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE 100.

1.3 SUBMITTALS

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

Shop drawings shall include detailed connection wiring diagrams and indicate all processors/platforms and connections to other systems such as SCADA, UMCS, Smart Metering or other. Identify the smart meter (utility metering) enclave and SCADA enclave. Provide all documentation necessary for Risk Management Framework. Refer to Section 25 05 11.05 Cybersecurity of Facility-Related Control Systems - Generator/Switchgear.

SD-02 Shop Drawings

Underground Conduit Routing Plan; G, DO

Panelboards; G, DO

This item may (and are encouraged to) be submitted for preliminary review only prior or concurrent to the submittal and approval of the Section 26 05 73 analyses.

Submit this item after or concurrent to Section 26 20 00 Item: CFCI Equipment Electrical Data.

Final CFCI Equipment Electrical Data; G, DO

Submit CFCI Equipment Electrical Data prior to or concurrent with Panelboards, Circuit Breakers (including enclosed), Low- to Low-Voltage Transformer, and Switches (26 20 00); Switchboards (and associated items; 26 24 13); and Section 26 05 73 studies and analyses.

Interim CFCI Equipment Electrical Data; G, DO
Interim CFCI Equipment Electrical Data (Fire Alarm); G, DO
Interim CFCI Equipment Electrical Data (Generator Station Service); G, DO
Interim CFCI Equipment Electrical Data (Filter Shelter); G, DO
Interim CFCI Equipment Electrical Data (Offload); G, DO

Busway; G, DO

Cable Trays; G, DO

Wireways; G, DO

Switchgear; G, DO

Marking Strips Drawings; G, DO

SD-03 Product Data

Receptacles; G, DO

Circuit Breakers (Switchboards); G, DO

Circuit Breakers (Other then Switchboards); G, DO

Switches; G, DO

Manual Transfer Switch; G, DO

Low- to Low-Voltage Transformers; G, DO

Submit Low- to Low-Voltage Transformers prior to or concurrent with Panelboards, Circuit Breakers (including enclosed), and Switches (26 20 00); Switchboards (and associated items; 26 24 13); and Section 26 05 73 studies and analyses.

Medium- to Low-Voltage Transformers; G, DO

Enclosed Circuit Breakers; G, DO

Motor Controllers; G, DO

Manual Motor Starters; G, DO

Metering; G, DO

Secondary Bonding Busbar; G, DO

Surge Protective Devices; G, DO

Cable Trays; G, DO

Adjustable Circuit Breaker Settings Cover; G, DO

Circuit Breaker Handle Locks and Lock-out Device; G, DO

Sealoffs; G, DO

Conductor Termination Adapters; G, DO

SD-05 Design Data

Cable Tray Design; G, DO

SD-06 Test Reports

600-volt Wiring Test; G, RO

Grounding System Test; G, RO

Low- to Low-Voltage Transformer Tests; G, RO

Medium- to Low-Voltage Transformer Tests; G, RO

Ground-fault Receptacle Test; G, RO

Arc-fault Receptacle Test; G, RO

SD-07 Certificates

Fuses; G, RO

SD-09 Manufacturer's Field Reports

Low- to Low-Voltage Transformer Factory Tests

Medium- to Low-Voltage Transformer Factory Tests

SD-10 Operation and Maintenance Data

Electrical Systems, Data Package 5; G, RO

Metering, Data Package 5; G, RO

1.3.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.4 QUALITY ASSURANCE

1.4.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with NFPA 70 unless more stringent requirements are specified or indicated. NECA NEIS 1 shall be considered the minimum standard for workmanship.

1.4.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.4.2.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.4.2.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable.

1.5 MAINTENANCE

1.5.1 Electrical Systems

Submit operation and maintenance data in accordance with Section 01 78 23, OPERATION AND MAINTENANCE DATA and as specified herein. Submit operation and maintenance manuals for electrical systems that provide basic data relating to the design, operation, and maintenance of the electrical distribution system for the building. Include the following:

a. Single line diagram of the "as-built" building electrical system.

b. Schematic diagram of electrical control system (other than HVAC, covered elsewhere).

c. Manufacturers' operating and maintenance manuals on active electrical equipment.

1.6 WARRANTY

Provide equipment items supported by service organizations that are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.7 SEISMIC REQUIREMENTS

Provide seismic details conforming to Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and to Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

1.8 Underground Conduit Routing Plan

Provide a plan expressing conduits routing underground both within the footprint of the building and those entering and/or exiting the building footprint (including those captured be Section 33 82 00). See coordinated submittal requirements regarding this submittal item with respect to impacted submittal content by other trades, most notably alterations and accommodations of footing reinforcement for conduit and ductbank with vertical routing through the footings.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

As a minimum, meet requirements of UL, where UL standards are established for those items, and requirements of NFPA 70 for all materials, equipment,

and devices.

2.2 CONDUIT AND FITTINGS

Conform to the following:

2.2.1 Rigid Metallic Conduit

2.2.1.1 Rigid, Threaded Zinc-Coated Steel Conduit

ANSI C80.1, UL 6.

2.2.1.2 Rigid Aluminum Conduit

ANSI C80.5, UL 6A.

2.2.2 Rigid Nonmetallic Conduit

PVC Type EPC-40, and EPC-80 in accordance with NEMA TC 2,UL 651.

2.2.3 Intermediate Metal Conduit (IMC)

UL 1242, zinc-coated steel only.

2.2.4 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

UL 797, ANSI C80.3.

2.2.5 Plastic-Coated Rigid Steel and IMC Conduit

NEMA RN 1, Type 40(40 mils thick).

Due to low soil resistivity measured at the site (leading to a "severe" corrosion potential), all non-concrete encased underground metallic conduits shall be plastic-coated.

2.2.6 Flexible Metal Conduit

UL 1, limited to 6 feet.

2.2.6.1 Liquid-Tight Flexible Metal Conduit, Steel

UL 360, limited to 6 feet.

2.2.7 Fittings for Metal Conduit, EMT, and Flexible Metal Conduit

UL 514B. Ferrous fittings: cadmium- or zinc-coated in accordance with UL 514B.

2.2.7.1 Fittings for Rigid Metal Conduit and IMC

Threaded-type. Split couplings unacceptable.

2.2.7.2 Fittings for EMT

Steel compression type.

2.2.8 Fittings for Rigid Nonmetallic Conduit

NEMA TC 3 for PVC, and UL 514B.

2.2.9 Liquid-Tight Flexible Nonmetallic Conduit

UL 1660.

2.3 BUSWAY

NEMA BU 1.1, UL 857. Provide the following:

a. Buses: copper.

b. Busways: rated 480 volts, 1200 continuous current amperes, three-phase, four-wire, and include integral or internal 50-percent ground bus.

c. Short circuit rating: 42,000 root mean square (rms) symmetrical amperes minimum.

d. Busway systems: suitable for use indoors.

e. Enclosures: metallic.

f. Hardware: plated or otherwise protected to resist corrosion.

g. Joints: one-bolt type with through-bolts, which can be checked for tightness without de-energizing system.

h. Maximum hot spot temperature rise at any point in busway at continuous rated load: do not exceed 55 degrees C above maximum ambient temperature of 40 degrees C in any position.

i. Internal barriers to prevent movement of superheated gases.

j. Coordinate proper voltage phasing of entire bus duct system, for example where busway interfaces with transformers, switchgear, switchboards, motor control centers, and other system components.

2.3.1 Feeder Busways

Provide ventilated, except that vertical busways within 6 feet of floors must be unventilated, low-impedance busway. Provide bus bars fully covered with insulating material, except at stabs. Provide an entirely polarized busway system.

2.4 CABLE TRAYS

NEMA VE 1. Provide the following:

Submit cable tray design, including dimensional layout, load and seismic calculations, and fill calculations. Dimensional layout includes cable spacings, cable tray splices, and supports. Fill calculations include an index of cables for each section and identification of the lb/ft, cross sectional area, and insulation voltage class for each cable. At the contractor's discretion, cable tray may be installed rooms with the term "Switchgear" (four rooms) for ease of installation and maintenance complying with NFPA 70.

a. Cable trays: form a wireway system, with a nominal 4 inch depth.

b. Cable trays: constructed of aluminum.

c. Cable trays: include splice and end plates, dropouts, and miscellaneous hardware.

d. Edges, fittings, and hardware: finished free from burrs and sharp edges.

e. Fittings: ensure not less than load-carrying ability of straight tray sections and have manufacturer's minimum standard radius.

f. Radius of bends: 12 inches but in no case shall be less than required to maintain manufacturers minimum cable bending radii.

2.4.1 Basket-Type Cable Trays

Provide sized to meet cabling capacity requirements with maximum wire mesh spacing of 2 by 4 inch. Cable tray to accommodate initial fill ratio of 25% and to not exceed 50% fill ratio.

2.4.2 Ladder-Type Cable Trays - For use in all Communication Rooms

Provide size as indicated with maximum rung spacing of 9 inches. Tray must be installed with the proper mounting hardware to securely fasten the tray to the walls and the top of the Floor-Mounted Racks. Tray shall be equipped with the proper grounding lugs to assure proper grounding and bonding of the tray. Provide side walls extending above the ladder rungs for the nominal height indicated on plans (Basis of Design: Legrand PW Ladder Cable Tray).

2.5 OPEN TELECOMMUNICATIONS CABLE SUPPORT

Open telecommunications cable support shall not be used.

2.6 OUTLET BOXES AND COVERS

UL 514A, cadmium- or zinc-coated, if ferrous metal. UL 514C, if nonmetallic.

2.6.1 Outlet Boxes for Telecommunications System

Provide the following:

a. Standard type 4 11/16 inches square by 2 1/8 inches deep.

b. Outlet boxes for single-connector, wall-mounted telecommunications phone outlets may be single-gang 4 by 2 1/8 by 2 1/8 inches deep.

c. Depth of boxes: large enough to allow manufacturers' recommended conductor bend radii.

2.7 CABINETS, JUNCTION BOXES, AND PULL BOXES

UL 50; volume greater than 100 cubic inches, NEMA Type 1 enclosure; sheet steel, hot-dip, zinc-coated. Where exposed to wet, damp, or corrosive environments, NEMA Type .

Reference E-### series sheets for environmental condition requirements (including hazardous locations) and provide appropriate cabinet, junction box, pull box, and terminal box enclosures, hubs, and connections for the conditions indicated.

2.8 WIRES AND CABLES

Provide wires and cables in accordance applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Do not use wires and cables manufactured more than 12 months prior to date of delivery to site.

2.8.1 Conductors

Provide the following:

a. Conductor sizes and capacities shown are based on copper, unless indicated otherwise.

b. Conductors No. 8 AWG and larger diameter: stranded.

c. Conductors No. 10 AWG and smaller diameter: solid.

d. Conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3: stranded unless specifically indicated otherwise.

e. All conductors: copper.

2.8.1.1 Minimum Conductor Sizes

Provide minimum conductor size in accordance with the following:

a. Branch circuits: No. 12 AWG.
The branch circuit sizes listed on the plans are minimum values. However, should a larger conductor size (with a larger diameter) be installed, the contractor is responsible for re-sizing raceways to account for the NFPA 70 fill ratio requirements.

b. Class 1 remote-control and signal circuits: No. 14 AWG.

c. Class 2 low-energy, remote-control and signal circuits: No. 16 AWG.

d. Class 3 low-energy, remote-control, alarm and signal circuits: No. 22 AWG.

e. Digital low voltage lighting control (DLVLC) system at 24 Volts or less: Category 5 UTP or better cables in accordance with DLVLC system manufacturer requirements. See Sheet TN500 for jacket color.

2.8.2 Color Coding

Provide color coding for service, feeder, branch, control, and signaling circuit conductors. Feeders shall be identified in accordance with NFPA 70 Article 215.12.

2.8.2.1 Ground and Neutral Conductors

Provide color coding of ground and neutral conductors as follows:

a. Grounding conductors: Green.

b. Neutral conductors: White.

c. Exception, where neutrals of more than one system are installed in same raceway or box, other neutrals color coding: white with a different colored (not green) stripe for each.

2.8.2.2 Ungrounded Conductors

Provide color coding of ungrounded conductors in different voltage systems as follows:

a. 208/120 volt, three-phase

(1) Phase A - black

(2) Phase B - red

(3) Phase C - blue

b. 480/277 volt, three-phase

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow

c. 120/240 volt, single phase: Black and red

d. On three-phase, four-wire delta system, high leg: orange, as required by NFPA 70.

2.8.3 Insulation

Unless specified or indicated otherwise or required by NFPA 70, provide power and lighting wires rated for 600-volts, Type THWN/THHN conforming to UL 83 or Type XHHW conforming to UL 44, except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits: Type TW or TF, conforming to UL 83. Where equipment or devices require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

For service entrance conductors, provide insulated conductors rated 600 volts and conforming to the requirements of NFPA 70, including listing requirements. Wires and cables manufactured more than 24 months prior to date of delivery to the site are not acceptable. Service entrance conductors must conform to UL 854, type USE.

Insulation values listed on the plans are minimum values (see "PANEL SCHEDULE KEY" entry for "MCIT" for final insulation value instructions). However, should a higher insulation value with a larger diameter be installed, the contractor is responsible for re-sizing raceways to account for the NFPA 70 fill ratio requirements.

2.8.4 Bonding Conductors

ASTM B1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.8.4.1 Telecommunications Bonding Backbone (TBB)

Provide a copper conductor TBB in accordance with TIA-607 with No. 6 AWG minimum size, and sized at 2 kcmil per linear foot of conductor length up to a maximum size of 750 kcmil. Provide insulated TBB with insulation as specified in the paragraph INSULATION and meeting the fire ratings of its pathway.

2.8.4.2 Bonding Conductor for Telecommunications

Provide a copper conductor Bonding Conductor for Telecommunications between the telecommunications main grounding busbar (PBB) and the electrical service ground in accordance with TIA-607. Size the bonding conductor for telecommunications the same as the TBB. Reference EG600 for minimum grounding bonding conductor sizes.

2.8.5 Service Entrance Cables

Service Entrance (SE) and Underground Service Entrance (USE) Cables, UL 854.

2.8.6 Wire and Cable for 28 VDC Circuits

Insulated copper conductors.

2.8.7 Metal-Clad Cable

UL 1569; NFPA 70, Type MC cable.

2.8.8 Cable Tray Cable or Power Limited Tray Cable

UL listed; type TC or PLTC.

2.9 SPLICES AND TERMINATION COMPONENTS

UL 486A-486B for wire connectors and UL 510 for insulating tapes. Connectors for No. 10 AWG and smaller diameter wires: insulated, pressure-type in accordance with UL 486A-486B or UL 486C (twist-on splicing connector). Must provide a uniform compression over the entire conductor contact surface. Provide solderless terminal lugs on stranded conductors.

2.10 DEVICE PLATES

Provide the following:

a. UL listed, one-piece device plates for outlets to suit the devices installed.

b. For metal outlet boxes, plates on unfinished walls: zinc-coated sheet steel or cast metal having round or beveled edges.

c. For nonmetallic boxes and fittings, other suitable plates may be provided.

d. Plates on finished walls: stainless steel,nylon or lexan, minimum 0.03 inch wall thickness and same color as receptacle or toggle switch with which they are mounted.

f. Screws: machine-type with countersunk heads in color to match finish of plate.

g. Sectional type device plates are not be permitted.

h. Plates installed in wet locations: gasketed and UL listed for "wet locations."

2.11 SWITCHES

2.11.1 Toggle Switches

NEMA WD 1, UL 20, single pole, double pole, three-way, and four-way, totally enclosed with bodies of thermoplastic or thermoset plastic and mounting strap with grounding screw. Include the following:

a. Handles: light gray thermoplastic.

b. Wiring terminals: screw-type, side-wired.

c. Contacts: silver-cadmium and contact arm - one-piece copper alloy.

d. Switches: rated quiet-type ac only, 120/277 volts, with current rating and number of poles indicated. Provide two-pole switch where indicated for 480V lighting circuits. See Equipment Electrical Connection Schedule for toggle switches which are required to be motor-rated (with thermal overloads) and/or a rating of 30A rather than 20A.

Switch sizes identified on plans are minimum sizes, and the contractor is responsible for increasing sizes to account for increased current drawn based on requirements of contractor-furnished equipment and/or for termination compatibility with conductor sizes increased due to voltage drop mitigation requirements and/or conductor ampacity corrections/adjustments for the ambient temperature or number of current-carrying conductors. (Additionally, see Subparts "Conductor Termination Adapters" and "CFCI Equipment Electrical Data")

2.11.2 Switch with Red Pilot Handle

NEMA WD 1. Provide the following:

a. Pilot lights that are integrally constructed as a part of the switch's handle.

b. Pilot light color: red and illuminate whenever the switch is closed or "on".

c. Pilot lighted switch: rated 20 amps and 120 volts as indicated.

d. The circuit's neutral conductor to each switch with a pilot light.

2.11.3 Disconnect Switches

NEMA KS 1. Provide heavy duty-type switches where indicated, where switches are rated higher than 240 volts, and for double-throw switches. Utilize Class R fuseholders and fuses for fused switches, unless indicated otherwise. Provide horsepower rated for switches serving as the motor-disconnect means. Provide switches in NEMA,. Provide switches in enclosure rated per NEMA ICS 6 and as indicated on the plans.

2.11.4 Manual Transfer Switch

Provide UL 1008 double-throw, manual/non-automatic transfer switches of configuration, NEMA ICS 6 enclosure rating, and minimum size indicated on EP600 series sheets. Provide service-entrance rated equipment where indicated.

Where indicated, manual/non-automatic transfer switches shall be equipped with a normally open relay output which closes upon transfer to the alternate power source.
[*Am-00002]
For manual transfer switches identified on one-line as requiring consideration, provide heating elements provided as determined by manufacturer specifications and component limitations. Perform calculations to confirm consistent heating of enclosure. Power from internal distribution.
[**Am-00002][*Am-00004]
For manual transfer switches whose alternate supply is a temporary generator connection, a combination manual transfer switch with connectors for the temporary supply complying with the standards identified in this subpart and with the requirements of the plans may be provided in lieu of separate manual transfer switch and connection cabinet. This provision is applicable only where such discrete elements are in the same location; that is, this provision to combine elements is not applicable in geographically separate locations, be it distance or the presence of a barrier (such as a wall, drainage swale, or other element prohibiting the placement and access of the temporary source in close proximity to the manual transfer switch).
[**Am-00004]

2.11.5 Switches Associated with Fire Alarm or Similar Equipment

Switches associated with fire alarm devices/equipment or similar equipment shall be red. Reference the panel schedules for circuits identified with notes as being "FIRE PROTECTION/LIFE SAFETY EQUIPMENT".

2.12 FUSES

NEMA FU 1. Provide complete set of fuses for each fusible switch. Coordinate time-current characteristics curves of fuses serving motors or connected in series with circuit breakers or other circuit protective devices for proper operation. Submit coordination data for approval. Provide fuses with a voltage rating not less than circuit voltage.

2.12.1 Fuseholders

Provide in accordance with UL 4248-1.

2.12.2 Cartridge Fuses, Current Limiting Type (Class R)

UL 248-12, Class RK-1. Provide only Class R associated fuseholders in

accordance with UL 4248-12.

2.12.3 Cartridge Fuses, High-Interrupting Capacity, Current Limiting Type (Classes J, L, and CC)

UL 248-8, UL 248-10, UL 248-4, Class J for zero to 600 amperes, Class L for 601 to 6,000 amperes, and Class CC for zero to 30 amperes.

2.12.4 Cartridge Fuses, Current Limiting Type (Class T)

UL 248-15, Class T for zero to 1,200 amperes, 300 volts; and zero to 800 amperes, 600 volts.

2.13 RECEPTACLES

Provide the following:

a. UL 498, general purpose specification grade, grounding-type. Residential grade receptacles are not acceptable.

b. Ratings and configurations: as indicated.

c. Bodies: light gray as per NEMA WD 1.

d. Face and body: thermoplastic supported on a metal mounting strap.

e. Dimensional requirements: per NEMA WD 6.

f. Screw-type, side-wired wiring terminals or of the solderless pressure type having suitable conductor-release arrangement.

g. Grounding pole connected to mounting strap.

h. The receptacle: containing triple-wipe power contacts and double or triple-wipe ground contacts.

i. Controlled receptacles: as required per ASHRAE 90.1. Provide marking for controlled receptacle per NFPA 70.

2.13.1 Weatherproof Receptacles

Provide receptacles, UL listed for use in "wet locations" with integral GFCI protection. Include cast metal box with gasketed, hinged, lockable and weatherproof while-in-use, die-cast metal/aluminum cover plate.

2.13.2 Ground-Fault Circuit Interrupter Receptacles

UL 943, duplex type for mounting in standard outlet box. Provide device capable of detecting current leak when the current to ground is 6 milliamperes or higher, and tripping per requirements of UL 943 for Class A ground-fault circuit interrupter devices. Provide screw-type, side-wired wiring terminals or pre-wired (pigtail) leads.

2.13.3 Plugs

Provide heavy-duty, rubber-covered three-, four-, or five-wire cord of required size, install plugs thereon, and attach to equipment. Provide UL listed plugs with receptacles, complete with grounding blades. Where equipment is not available, turn over plugs and cord assemblies to the

Government.

2.13.4 Tamper-Resistant Receptacles

Provide duplex receptacle with mechanical sliding shutters that prevent the insertion of small objects into its contact slots.

2.13.5 Arc-Fault Circuit Interrupter Receptacles

UL 1699, duplex type for mounting in standard outlet box. Provide device capable of detecting series arcing current when the current to ground is 5 amperes or higher, and tripping per requirements of UL 1699.

2.13.6 Hazardous-Rated Receptacles

Provide UL-listed receptacles rated for Class I Division II locations as appropriate based on hazardous plans on E-### series sheets and as depicted on plans.

2.14 PANELBOARDS

Provide panelboards in accordance with the following:

a. UL 67 and UL 50 having a minimum short-circuit current rating as indicated on the drawings or as established by the studies required by Section 26 05 73, POWER SYSTEMS STUDIES, whichever is greater.

b. Panelboards for use as service disconnecting means: additionally conform to UL 869A.

c. Panelboards: circuit breaker-equipped.

d. Designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL.

e. "Specific breaker placement" is required in panelboards to match the breaker placement indicated in the panelboard schedule on the design drawings. Include in submittal a narrative explanation in situations where "Specific breaker placement" is not possible due to equipment/device limitation(s). A variance request for relocation is required and is subject to government review and approval.

f. Use of "Subfeed Breakers" is not acceptable.

g. Main breaker: "separately" mounted "above" or "below" branch breakers.

h. Where "space only" is indicated, make provisions for future installation of breakers.

i. Directories: indicate load served by each circuit in panelboard. Use the load names in the panel schedules as a basis, however, omit commentary items in "< >" (such as "< BID OPTION >") of a given circuit. Directories shall represent the final installed condition of the panelboard circuits (such as spares and spaces in place of anticipated or contingency circuits); some circuits indicated on plans are contingent upon base or bid option award or upon the equipment selected by the contractor. For equipment connections requiring

receptacles and a receptacle is not shown as the basis of design connection, add "RECEPTACLE" to the load name similar to equipment connected by receptacle already shown; likewise, where a receptacle is indicated but the equipment installed requires a different connection, remove "RECEPTACLE" from the load name in the directory.

j. Directories: indicate source of service to panelboard (e.g., Panel PA served from Panel MDP in Room ###).

l. Type directories and mount in holder behind transparent protective covering.

m. Panelboards: listed and labeled for their intended use.

n. Panelboard nameplates: provided in accordance with paragraph FIELD FABRICATED NAMEPLATES.

o. Submit panelboard elevation drawings indicating at minimum the following:

(1) Circuit breaker and space layout.
(2) Circuit breaker rating, poles, and model information.
(3) Name of load assigned to each circuit (may be omitted in situations where all circuit breakers are identical (such as all 20A circuit breakers on a lighting panel) or the individual differences are obvious (a few are lockable or GFCI).
(4) Branch circuit frame size mismatch/limitations (if applicable).
(5) Enclosure dimensions.
(6) Enclosure ratings (NEMA ICS 6, bus, SCCR, etc.).
(7) Enclosure properties (bus material, mounting, SE label, series rated, system voltage, number of sections).
(8) Components list and options included.
(9) Dimension from floor to center of highest operating handle for NFPA 70 compliance (6 ft 7 in).
(10) The mounting height to bottom to demonstrate elevation above hazardous areas (where applicable), and allow for the proper installation of conduits entering the bottom of equipment and the associated sealoff (where applicable).

p. Submit bill of materials for each panelboard to include quantities and catalog number of each component.

Reference Section 28 31 70 Subpart "Primary Power" for coordination of devices and equipment to be supplied from the "Dedicated Emergency Panel Schedule". Final approval for distribution equipment covered by this Section for elements pertaining to the fire alarm and related systems will not be considered until the Section 28 31 70 "Dedicated Emergency Panel Schedule" is approved, which requires a substantially-developed fire alarm/etc. systems design; Coordinate across trades for timely delivery of this information.

2.14.1 Enclosure

Provide panelboard enclosure in accordance with the following:

a. UL 50.

b. Cabinets mounted outdoors or flush-mounted: hot-dipped galvanized

after fabrication .

c. Cabinets: painted in accordance with paragraph PAINTING.

d. Outdoor cabinets: NEMA 4x with conduit hubs welded to the cabinet. [*Am-00002] For enclosures identified on one-line as requiring consideration, provide heating elements as determined by manufacturer specifications and component limitations. Perform calculations to confirm consistent heating of enclosure. Power from internal distribution or from panel circuit breaker. If powering from circuit breaker, ensure all other electrical requirements and panel related design limitations are still met.[**Am-00002]

e. Front edges of cabinets: form-flanged or fitted with structural shapes welded or riveted to the sheet steel, for supporting the panelboard front.

f. All cabinets: fabricated such that no part of any surface on the finished cabinet deviates from a true plane by more than 1/8 inch.

g. Holes: provided in the back of indoor surface-mounted cabinets, with outside spacers and inside stiffeners, for mounting the cabinets with a 1/2 inch clear space between the back of the cabinet and the wall surface.

h. Flush doors: mounted on hinges that expose only the hinge roll to view when the door is closed.

i. Each door: fitted with a combined catch and lock latch and provided with a hinged trim assembly.

j. Keys: two provided with each lock, with all locks keyed alike.

k. Finished-head cap screws: provided for mounting the panelboard fronts on the cabinets.

2.14.2 Panelboard Buses

Support bus bars on bases independent of circuit breakers. Design main buses and back pans so that breakers may be changed without machining, drilling, or tapping. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet. In addition to equipment grounding bus, provide second "isolated" ground bus, where indicated.

2.14.2.1 Panelboard Neutrals for Non-Linear Loads

Panel schedules shown on the plans with 200% neutral shall be considered panelboards supporting non-linear loads. Provide in accordance with the following:

a. UL listed, with panelboard type specifically UL heat rise tested for use on non-linear loads.

b. Panelboard: heat rise tested in accordance with UL 67, except with the neutral assembly installed and carrying 200 percent of the phase bus current during testing.

c. Verification of the testing procedure: provided upon request.

d. Two neutral assemblies paralleled together with cable is not acceptable.

e. Nameplates for panelboard rated for use on non-linear loads: marked "SUITABLE FOR NON-LINEAR LOADS" and in accordance with paragraph FIELD FABRICATED NAMEPLATES.

f. Provide a neutral label with instructions for wiring the neutral of panelboards rated for use on non-linear loads.

2.14.3 Circuit Breakers

To ease grouping of submittals in coordination and sequencing, furnish information as "Circuit Breakers (Switchboards)" and "Circuit Breakers (Other then Switchboards)"

UL 489, having a minimum short-circuit current rating equal to the short-circuit current rating of the panelboard in which the circuit breaker will be mounted. Breaker terminals: UL listed as suitable for type of conductor provided. Where indicated on the drawings, provide circuit breakers with shunt trip devices. Series rated circuit breakers and plug-in circuit breakers are unacceptable.

UL 489 solid-state circuit breakers shall be used where indicated on the plans and in Section 26 05 73 POWER SYSTEM STUDIES. Thermal-magnetic type shall be used in all locations not indicated to be solid-state type.

The circuit breaker ratings indicated on the panel schedules are estimates based on basis of design equipment or standard ratings. Both solid-state and thermal magnetic-type circuit breaker ratings and/or settings are subject to change based on the manufacturer recommendations for equipment to be provided in this contract, including transformer inrush values and values for equipment listed on the "Equipment Electrical Connection Schedule". Contractor shall coordinate the protection device ratings with the equipment approved to be installed, is responsible for providing the appropriate ratings/settings, and shall indicate deviations from the design ratings in the submittal process.

Reference Section 28 31 70 Section "Primary Power" for coordination of devices and equipment to be supplied from the "Dedicated Emergency Panel Schedule". Final approval for distribution equipment covered by this Section for elements pertaining to the fire alarm and related systems will not be considered until the Section 28 31 70 "Dedicated Emergency Panel Schedule" is approved, which requires a substantially-developed fire alarm/mass notification/releasing service/containment/etc. systems design; Coordinate across trades for timely delivery of this information.

Specific specialty type circuit breakers found on the plans and schedules including but not limited to GFCI, AFCI, shunt trip, devices with red handles, and those lockable in the ON and/or OFF position (or appurtenances used for the satisfaction of said requirements) shall be included in the Circuit Breakers submittal.

Circuit breaker types shall be based on the protective coordination study to selectively coordinate to the degree indicated in Section 26 05 73 POWER SYSTEM STUDIES. Circuit breaker types shall be adjusted in accordance with the recommendations resulting from the studies performed.

However, adjustments shall not be performed which compromise the criteria- or manufacturer-required protection of equipment (such as NFPA 70 Section 450.3 primary and secondary protection limits for transformers or manufacturer-recommended MOCP values, respectively). Examples of such adjustments are changing from one model line of a given manufacturer to another for specific troublesome protective devices preventing an acceptable level of coordinated protection selectivity (such as from Siemens HGB or BQD to Siemens FXD6, from Siemens BQD for Siemens NGB, from Siemens BL for Siemens BLH). Circuit breakers shall not be considered accepted until protective coordination study is accepted with "A" or "B" Action.

2.14.3.1 Multipole Breakers

Provide common trip-type with single operating handle. Design breaker such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.

2.14.3.2 Circuit Breaker With Ground-Fault Circuit Interrupter

UL 943 and NFPA 70. Provide with auto-monitoring (self-test) and lockout features, "push-to-test" button, visible indication of tripped condition, and ability to detect and trip when current imbalance is 6 milliamperes or higher per requirements of UL 943 for Class A ground-fault circuit interrupter devices.

2.14.3.3 Arc-Fault Circuit Interrupters

UL 489, UL 1699 and NFPA 70. Molded case circuit breakers: rated as indicated. Two pole arc-fault circuit-interrupters: rated 120/240 volts. The provision of (two) one pole circuit breakers for shared neutral circuits in lieu of (one) two pole circuit breaker is unacceptable. Provide with "push-to-test" button.

2.14.3.4 Solid-State Trip Elements

Solid-state circuit breakers shall be provided at the locations indicated on the EP600 panel schedules. All electronics shall be self-contained and require no external relaying, power supply, or accessories. Printed circuit cards shall be treated to resist moisture absorption, fungus growth, and signal leakage. All electronics shall be housed in an enclosure which provides protection against arcs, magnetic interference, dust, and other contaminants. Solid-state sensing shall measure true RMS current with error less than one percent on systems with distortions through the 13th harmonic. Peak or average actuating devices are not acceptable. Current sensors shall be toroidal construction, encased in a plastic housing filled with epoxy to protect against damage and moisture and shall be integrally mounted on the breaker. Where indicated on the drawings, circuit breaker frames shall be rated for 100 percent continuous duty. Circuit breakers shall have tripping features as shown on the drawings and as described below:

a. Long-time current pick-up, adjustable from 50 percent to 100 percent of continuous current rating.

b. Adjustable long-time delay.

c. Short-time current pick-up, adjustable from 1.5 to 9 times long-time

current setting.

d. Adjustable short-time delay.

e. Short-time I square times t switch.

f. Instantaneous current pick-up, adjustable from 1.5 to 9 times long-time current setting.

g. (At locations indicated on the plans) Ground-fault pick-up, adjustable from 20 percent to 60 percent of sensor rating, but in no case greater than 1200 amperes. Sensing of ground-fault current at the main bonding jumper or ground strap shall not be permitted.

h. (At locations indicated on the plans) Adjustable ground-fault delay.

i. (At locations indicated on the plans) Ground-fault I square times t switch.

j. Overload, Short-circuit, Ground-fault (as applicable) trip indicators shall be provided.

k. Provide circuit breakers with high-instantaneous trip properties where needed to satisfy selective coordination requirements. See Section 26 05 73 POWER SYSTEM STUDIES.

2.14.3.4.1 Circuits Protected by Solid-State (Adjustable) Trip Elements

Circuits protected by solid-state (adjustable) trip elements are shown sized for the value identified on the panel schedules, one-line diagrams, and other elements where circuit sizing is indicated on the plans and account for ampacity correction and adjustment factors. Except where indicated otherwise, all adjustable trip circuit breakers shall be provided with a restricting means described in NFPA 70 Section 240.6(C), and that means shall be a removable and sealable cover (240.6(C)(1)); the others means described in NFPA 70 Section 240.6(C) are not acceptable.

Should the solid-state (adjustable) circuit breaker not be restricted by a means described in NFPA 70 Section 240.6(C) and the trip element is capable of a rating greater than the value identified in the diagram and schedules described above, the contractor is responsible for changing the conductor and raceway size(s) at no additional cost to the government to satisfy NFPA 70 Section 240.6(B), and shall account for all correction and adjustment factors stated in NFPA 70 and UFC 3-520-01 and to maintain compliance with the voltage drop requirements of ASHRAE 90.1 and UFC 3-501-01 for the proportional load increase relative to the original circuit breaker rating indicated on the plans. The contractor shall submit such changes for government approval as Adjustable-Trip Circuit Breaker Circuit Corrections. This shall include circuits whose protection is on the load end of the conductors (such as transformer secondary conductors). Bonding jumpers and equipment grounding conductors shall likewise be adjusted.

Where restricted by a means described in NFPA 70 Section 240.6(C) and the trip element is capable of a rating greater than the value identified in the diagram and schedules described above, provide a label for the circuit breaker indicating the conductors are sized to an adjusted trip rating below the maximum capable by the trip element and state the rating to which the conductors are sized.

Electronic circuit breakers may be used in other applications at the contractor's discretion (i.e., utilizing a larger frame with a smaller plug trip rating in order to land larger conductors on the terminals).

2.14.3.4.2 Adjustable Circuit Breaker Settings Cover

All adjustable circuit breakers shall be provided with a removable sealable cover over the adjusting means in accordance with NFPA 70. Covers shall be sized appropriately for each circuit breaker to enclose all adjustable breaker trip settings without interfering with normal breaker operability. Cover shall be of transparent plastic which allows for unobstructed visibility of breaker settings while restricting physical access to the adjusting means. Cover shall be sealable by means of screws, bolts, or other approved locking means.

2.14.3.5 Maintenance Switch

Where a solid-state circuit breaker is rated for or can be adjusted to 800 amperes or higher, the device shall be provided with an auxiliary two-position arc energy-reducing maintenance switching with local status indicator. Positions shall be labeled "NORMAL OPERATION" and "MAINTENANCE". "NORMAL OPERATION" shall provide the protection settings identified by and approved in the protective coordination study. "MAINTENANCE" shall change the instantaneous and short-time current pick-up settings to the lowest values permitted by the device.

2.14.3.6 Circuit Breaker Handle Locks and Lock-out Device

All circuit breakers supplying fire alarm circuits, or as otherwise indicated in the drawings, shall be provided with handle locks capable of securing the circuit breaker in the On or Off position. Handle locks intended as lock-on devices for circuit breakers feeding fire alarm circuits shall be non-padlock, screw type devices. Lock-out devices intended to secure circuit breakers in the Off position shall be padlockable. Handle locks and lock-out devices shall be sized appropriately for each circuit breaker they are intended to be secured to.

2.14.3.7 Enclosed Circuit Breakers

UL 489. Individual molded case circuit breakers with voltage and continuous current ratings, number of poles, overload trip setting, and short circuit current interrupting rating as indicated. Enclosure type as indicated. Provide solid neutral unless otherwise noted.

Similar to the Circuit Breakers submittal, specific specialty type enclosed circuit breakers found on the plans and schedules (or appurtenances used for the satisfaction of said requirements) shall be included in the Enclosed Circuit Breakers submittal.

[*Am-00002]

Heating elements provided as determined by manufacturer specifications and component limitations. Perform calculations to confirm consistent heating of enclosure. Power from internal distribution. [**Am-00002]

2.15 MOTOR SHORT-CIRCUIT PROTECTOR (MSCP)

Motor short-circuit protectors, also called motor circuit protectors (MCPs): UL 508 and UL 489, and provided as shown. Provide MSCPs that consist of an adjustable instantaneous trip circuit breaker used only in

conjunction with a combination motor controller which provides coordinated motor branch-circuit overload and short-circuit protection. Rate MSCPs in accordance with the requirements of NFPA 70.

2.16 TRANSFORMERS

2.16.1 Low- to Low-Voltage Transformers

Provide transformers in accordance with the following:

a. NEMA ST 20, general purpose, dry-type, self-cooled, ventilated, except sealed where indicated to be NEMA 4.

b. Provide transformers in NEMA enclosure rating as indicated on the transformer schedule.

c. Taps for transformers 15 kVA and larger: Two 2.5 percent taps Full Capacity Above Nominal (FCAN) and four 2.5 percent taps Full Capacity Below Nominal (FCBN) .

d. Transformer insulation system:

(1) 220 degrees C insulation system for transformers 15 kVA and greater, with temperature rise not exceeding 115 degrees C under full-rated load in maximum ambient of 40 degrees C.

(2) 180 degrees C insulation for transformers rated 10 kVA and less, with temperature rise not exceeding 80 degrees C under full-rated load in maximum ambient of 40 degrees C.

e. Transformer of 150 degrees C temperature rise is not acceptable.

f. Transformer of 115 degrees C temperature rise: capable of carrying continuously 115 percent of nameplate kVA without exceeding insulation rating.

g. Transformer of 80 degrees C temperature rise: capable of carrying continuously 130 percent of nameplate kVA without exceeding insulation rating.

h. Manufacturer transformer inrush data shall be available and provided for use under Section 26 05 73 COORDINATED POWER SYSTEM PROTECTION WITH ARC FLASH HAZARD STUDY.

i. See Sheet EP600 regarding requirements completely enclosed transformers in accordance with NFPA 70 Section 450.21(B) Exception #2 for specific transformer(s).

2.16.1.1 Specified Transformer Efficiency

Transformers, indicated and specified with: 480V primary, 80 degrees C or 115 degrees C temperature rise, kVA ratings of 37.5 to 100 for single phase or 30 to 500 for three phase, energy efficient type. The transformer is not acceptable if the calculated transformer efficiency is less than the efficiency indicated in 10 CFR 431, Subpart K.

2.16.1.2 Transformers With Non-Linear Loads

Provide transformers for non-linear loads in accordance with the following:

a. Transformer insulation: UL recognized 220 degrees C system. Neither the primary nor the secondary temperature is allowed to exceed 220 degrees C at any point in the coils while carrying their full rating of non-sinusoidal load.

b. Transformers are to be UL listed and labeled for K-Factor rating as indicated in accordance with UL 1561.

c. Transformers evaluated by the UL K-Factor evaluation: listed for not greater than 115 degrees C average temperature rise only.

d. Transformers with K-Factor ratings with temperature rise of 150 degrees C rise are not acceptable.

e. K-Factor rated transformers impedance: allowed range of 3 percent to 5 percent, with a minimum reactance of 2 percent to prevent excessive neutral current when supplying loads with large amounts of third harmonic.

2.16.2 Medium- to Low-Voltage Transformers

IEEE C57.12.01, and IEEE C57.12.51 for dry-type transformers rated 501 kVA and larger. Transformer base must be fabricated of type 304 or 304L stainless steel. Transformer base must include any part of the transformer that is within 3 inches of concrete pad. Windings must be copper.

Provide a vacuum pressure impregnated (VPI) type transformer with an insulation system rated 220 degrees C, and with an 80 degree C average winding temperature rise above a 40 degrees C maximum ambient.

2.16.2.1 Transformer Ratings

Transformer must be rated 95 kV BIL Primary and 10 kV BIL Secondary, with KVA as indicated.

a. Transformer voltage ratings: As indicated.

b. Provide four 2.5 percent full capacity taps, two above and two below rated primary voltage. Locate tap adjustments on the face of the high voltage coil. Adjustments must be accessible by removing the front panel and must be made when the transformer is de-energized.

c. Audible sound levels must comply with the following:

kVA	DECIBELS (MAX)
750	64

d. Diagrammatic stainless steel or laser-etched anodized aluminum nameplate.

e. Transformer must include ground pads, lifting lugs and provisions for jacking under base. See S-### series sheets for pad details. The transformer base construction must be suitable for using rollers or skidding in any direction. The transformer must have an insulated low-voltage neutral bushing with lugs for ground cable, and with removable ground strap.

f. Dry type transformer must have the following accessories.

g. Winding temperature indicator

2.17 MOTORS

Provide motors in accordance with the following:

a. NEMA MG 1 except provide fire pump motors as specified in Section 21 30 00 FIRE PUMPS.

b. Hermetic-type sealed motor compressors: Also comply with UL 984.

c. Provide the size in terms of HP, or kVA, or full-load current, or a combination of these characteristics, and other characteristics, of each motor as indicated or specified.

d. Determine specific motor characteristics to ensure provision of correctly sized starters and overload heaters.

e. Rate motors for operation on 208-volt, 3-phase circuits with a terminal voltage rating of 200 volts, and those for operation on 480-volt, 3-phase circuits with a terminal voltage rating of 460 volts.

f. Use motors designed to operate at full capacity with voltage variation of plus or minus 10 percent of motor voltage rating.

g. Unless otherwise indicated, use continuous duty type motors if rated 1 HP and above.

h. Where fuse protection is specifically recommended by the equipment manufacturer, provide fused switches in lieu of non-fused switches indicated.

i. Use Inverter-Rated motors designed to operate with adjustable speed drive (ASD).

[*Am-00002]

j. Coordinate with the motor supplier to determine and provide accordingly the requisite thermal protection, and coordinate across trades for the location of the thermal protection, which may be a combination device encompassing the motor thermal protection, the motor disconnecting means, and/or the motor control device.[**Am-00002]

2.17.1 High Efficiency Single-Phase Motors

Single-phase fractional-horsepower alternating-current motors: high efficiency types are not acceptable. In exception, for special purpose motors and motor-driven equipment with a minimum seasonal or overall efficiency rating, such as a SEER rating, provide equipment with motor to meet the overall system rating indicated.

2.17.2 Premium Efficiency Polyphase and Single-Phase Motors

Select polyphase and continuous-duty single phase motors based on high efficiency characteristics relative to typical characteristics and applications as listed in NEMA MG 10 and NEMA MG 11. In addition, continuous rated, polyphase squirrel-cage medium induction motors must meet the requirements for premium efficiency electric motors in accordance

with NEMA MG 1, including the NEMA full load efficiency ratings. In exception, for motor-driven equipment with a minimum seasonal or overall efficiency rating, such as a SEER rating, provide equipment with motor to meet the overall system rating indicated.

2.17.3 Motor Sizes

Provide size for duty to be performed, not exceeding the full-load nameplate current rating when driven equipment is operated at specified capacity under most severe conditions likely to be encountered. When motor size provided differs from size indicated or specified, make adjustments to wiring, disconnect devices, and branch circuit protection to accommodate equipment actually provided. Provide controllers for motors rated 1-hp and above with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

2.17.4 Wiring and Conduit

Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide power wiring and conduit for field-installed equipment using adjustable speed drive (ASD) manufacturer required wiring type and length, (where applicable)and motor control equipment forming part of motor control centers or switchgear assemblies, the conduit and wiring connecting such centers, assemblies, or other power sources to equipment as specified herein. Power wiring and conduit: conform to the requirements specified herein. Control wiring: provided under, and conform to, the requirements of the section specifying the associated equipment.

2.18 MOTOR CONTROLLERS

Provide motor controllers in accordance with the following:

a. UL 508, NEMA ICS 1, and NEMA ICS 2, except fire pump controllers as specified in Section 21 30 00 FIRE PUMPS.

b. Provide controllers with thermal overload protection in each phase, and one spare normally open auxiliary contact, and one spare normally closed auxiliary contact.

c. Provide controllers for motors rated 1-hp and above with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage.

d. Provide protection for motors from immediate restart by a time adjustable restart relay.

e. When used with pressure, float, or similar automatic-type or maintained-contact switch, provide a hand/off/automatic selector switch with the controller.

f. Connections to selector switch: wired such that only normal automatic regulatory control devices are bypassed when switch is in "hand" position.

g. Safety control devices, such as low and high pressure cutouts, high temperature cutouts, and motor overload protective devices: connected

in motor control circuit in "hand" and "automatic" positions.

h. Control circuit connections to hand/off/automatic selector switch or to more than one automatic regulatory control device: made in accordance with indicated or manufacturer's approved wiring diagram.

i. Provide selector switch with the means for locking in any position.

j. Provide a disconnecting means, capable of being locked in the open position, for the motor that is located in sight from the motor location and the driven machinery location. As an alternative, provide a motor controller disconnect, capable of being locked in the open position, to serve as the disconnecting means for the motor if it is in sight from the motor location and the driven machinery location.

k. Overload protective devices: provide adequate protection to motor windings; be thermal inverse-time-limit type; and include manual reset-type pushbutton on outside of motor controller case.

l. Cover of combination motor controller and manual switch or circuit breaker: interlocked with operating handle of switch or circuit breaker so that cover cannot be opened unless handle of switch or circuit breaker is in "off" position.

m. Minimum short circuit withstand rating of combination motor controller: shall be the rating of the supply panelboard/switchboard.

n. Provide controllers in hazardous locations with classifications as indicated on the E-### series sheets.

Controller sizes identified on plans are minimum sizes, and the contractor is responsible for increasing sizes to account for increased current drawn based on requirements of contractor-furnished equipment and/or for termination compatibility with conductor sizes increased due to voltage drop mitigation requirements and/or conductor ampacity corrections/adjustments for the ambient temperature or number of current-carrying conductors. (Additionally, see Subparts "Conductor Termination Adapters" and "CFCI Equipment Electrical Data")

2.18.1 Control Wiring

Provide control wiring in accordance with the following:

a. All control wire: stranded tinned copper switchboard wire with 600-volt flame-retardant insulation Type SIS meeting UL 44, or Type MTW meeting UL 1063, and passing the VW-1 flame tests included in those standards.

b. Hinge wire: Class K stranding.

c. Current transformer secondary leads: not smaller than No. 10 AWG.

d. Control wire minimum size: No. 14 AWG.

e. Power wiring for 480-volt circuits and below: the same type as control wiring with No. 12 AWG minimum size.

f. Provide wiring and terminal arrangement on the terminal blocks to permit the individual conductors of each external cable to be

terminated on adjacent terminal points.

2.18.2 Control Circuit Terminal Blocks

Provide control circuit terminal blocks in accordance with the following:

a. NEMA ICS 4.

b. Control circuit terminal blocks for control wiring: molded or fabricated type with barriers, rated not less than 600 volts.

c. Provide terminals with removable binding, fillister or washer head screw type, or of the stud type with contact and locking nuts.

d. Terminals: not less than No. 10 in size with sufficient length and space for connecting at least two indented terminals for 10 AWG conductors to each terminal.

e. Terminal arrangement: subject to the approval of the Contracting Officer with not less than four spare terminals or 10 percent, whichever is greater, provided on each block or group of blocks.

f. Modular, pull apart, terminal blocks are acceptable provided they are of the channel or rail-mounted type.

g. Submit data showing that any proposed alternate will accommodate the specified number of wires, are of adequate current-carrying capacity, and are constructed to assure positive contact between current-carrying parts.

2.18.2.1 Types of Terminal Blocks

a. Short-Circuiting Type: Short-circuiting type terminal blocks: furnished for all current transformer secondary leads with provision for shorting together all leads from each current transformer without first opening any circuit. Terminal blocks: comply with the requirements of paragraph CONTROL CIRCUIT TERMINAL BLOCKS above.

b. Load Type: Load terminal blocks rated not less than 600 volts and of adequate capacity: provided for the conductors for NEMA Size 3 and smaller motor controllers and for other power circuits, except those for feeder tap units. Provide terminals of either the stud type with contact nuts and locking nuts or of the removable screw type, having length and space for at least two indented terminals of the size required on the conductors to be terminated. For conductors rated more than 50 amperes, provide screws with hexagonal heads. Conducting parts between connected terminals must have adequate contact surface and cross-section to operate without overheating. Provide each connected terminal with the circuit designation or wire number placed on or near the terminal in permanent contrasting color.

2.18.3 Control Circuits

Control circuits: maximum voltage of 120 volts derived from control transformer in same enclosure. Transformers: conform to UL 506, as applicable. Transformers, other than transformers in bridge circuits: provide primaries wound for voltage available and secondaries wound for correct control circuit voltage. Size transformers so that 80 percent of rated capacity equals connected load. Provide disconnect switch on

primary side. Provide one fused secondary lead with the other lead grounded.

2.18.4 Enclosures for Motor Controllers

NEMA ICS 6.

2.18.5 Multiple-Speed Motor Controllers and Reversible Motor Controllers

Across-the-line-type, electrically and mechanically interlocked. Multiple-speed controllers: include compelling relays and multiple-button, station-type with pilot lights for each speed.

2.18.6 Pushbutton Stations

Provide with "start/stop" momentary contacts having one normally open and one normally closed set of contacts, and red lights to indicate when motor is running. Stations: heavy duty, oil-tight design.

2.18.7 Pilot and Indicating Lights

Provide LED cluster lamps.

2.19 MANUAL MOTOR STARTERS (MOTOR RATED SWITCHES)

SingleDoubleThree pole designed for flush mounting with overload protection and pilot lights.

2.19.1 Pilot Lights

Provide yoke-mounted, seven element LED cluster light module. Color: in accordance with NEMA ICS 2.

2.20 LOCKOUT REQUIREMENTS

Provide circuit breakers, disconnecting means, and other devices that are electrical energy-isolating capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147, NFPA 70E and 29 CFR 1910.303. Comply with requirements of Division 23, "Mechanical" for mechanical isolation of machines and other equipment.

2.21 TELECOMMUNICATIONS SYSTEM

Provide system of telecommunications wire-supporting structures (pathway), including: outlet boxes, conduits with pull wires and other accessories for telecommunications outlets and pathway in accordance with TIA-569 and as specified herein. Additional telecommunications requirements are specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

2.21.1 Backboards

Provide void-free, fire rated interior grade plywood, 3/4 inch thick, 4 by 8 feet. Do not cover the fire stamp on the backboard. Coordinate backboard requirements with telecommunications backboard requirements as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING.

2.22 GROUNDING AND BONDING EQUIPMENT

2.22.1 Ground Rods

UL 467. Ground rods: cone pointed copper-clad steel, with minimum diameter of 3/4 inch and minimum length 10 feet. Sectional type rods may be used for rods 20 feet or longer.

2.22.2 Ground Bus

Copper ground bus: provided in the electrical rooms as indicated on the plans.

2.22.3 Secondary Bonding Busbar

Provide corrosion-resistant grounding busbar suitable for indoor installation in accordance with TIA-607. Busbars: plated for reduced contact resistance. If not plated, clean the busbar prior to fastening the conductors to the busbar and apply an anti-oxidant to the contact area to control corrosion and reduce contact resistance. Provide a Primary bonding busbar (TGB) in the telecommunications entrance facility. The Primary bonding busbar (TGB) sized in accordance with the immediate application requirements and with consideration of future growth. Provide Primary bonding busbars with the following:

a. Predrilled copper busbar provided with holes for use with standard sized lugs,

b. Minimum dimensions of 0.25 in thick by 4 in wide for the TGB with length as indicated;

c. Listed by a nationally recognized testing laboratory.

2.23 HAZARDOUS LOCATIONS

Electrical materials, equipment, and devices for installation in hazardous locations, as defined by NFPA 70: specifically approved by Underwriters' Laboratories, Inc., or Factory Mutual for particular "Class," "Division," and "Group" of hazardous locations involved. Boundaries and classifications of hazardous locations: as indicated. Equipment in hazardous locations: comply with UL 1203 for electrical equipment, UL 877 for circuit breakers, UL 886 for outlet boxes and fittings, UL 1010 for receptacles, UL 698A for industrial controls, and UL 674 for motors.

2.24 MANUFACTURER'S NAMEPLATE

Provide on each item of equipment a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.25 FIELD FABRICATED NAMEPLATES

Provide field fabricated nameplates in accordance with the following:

a. ASTM D709.

b. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the

drawings.

c. Each nameplate inscription: identify the function and, when applicable, the position.

d. Nameplates: melamine plastic, 0.125 inch thick, white with black center core.

e. Provide red laminated plastic label with white center core where indicated.

f. Surface: matte finish. Corners: square. Accurately align lettering and engrave into the core.

g. Minimum size of nameplates: one by 2.5 inches.

h. Lettering size and style: a minimum of 0.25 inch high normal block style.

2.26 WARNING SIGNS

Provide warning signs for flash protection in accordance with NFPA 70E and NEMA Z535.4 for switchboards, panelboards, industrial control panels, and motor control centers that are in other than dwelling occupancies and are likely to require examination, adjustment, servicing, or maintenance while energized. Provide field installed signs to warn qualified persons of potential electric arc flash hazards when warning signs are not provided by the manufacturer. Provide marking that is clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

2.27 FIRESTOPPING MATERIALS

Provide firestopping around electrical penetrations in accordance with Section 07 84 00 FIRESTOPPING.

2.28 WIREWAYS

UL 870. Material: steel galvanized 16 gauge for heights and depths up to 6 by 6 inches, and 14 gauge for heights and depths up to 12 by 12 inches. Provide in length required for the application with screw - cover NEMAappropriate for application (match ratings of area equipment) enclosure per NEMA ICS 6.

2.29 METERING

Reference Section 26 24 13, SWITCHBOARDS. Metering requirements from Section 26 24 13, SWITCHBOARDS shall also apply to service-entrance panelboard(s). ANSI C12.1.

2.30 SURGE PROTECTIVE DEVICES

Provide parallel type surge protective devices (SPD) which comply with UL 1449 at the service entrance, panelboards, and switchboards where indicated on the EP600 series one-line diagram and panel schedules, and as indicated elsewhere in the contract drawings and specifications; this shall include both distribution equipment surge protective devices (where required at panelboards, distribution panels, switchboards, switchgear, etc.) and branch circuit surge protective devices. Provide surge

protectors in an enclosure matching the NEMA ICS 6 rating identified for the protected equipment (See EP620 series panel schedules). SPD must have the same short-circuit current rating as the protected equipment and must not be installed at a point of system where the available fault current is in excess of that rating. Use Type 1 or Type 2 SPD and connect on the load side of a dedicated circuit breaker unless otherwise indicated; use of a fuse in lieu of circuit breaker is not acceptable. Do not install SPD inside a panel enclosure. The maximum lead length permitted is 3'. Submit performance and characteristic curves. Provide Form C dry contacts for remote monitoring, and indicate to the reporting system when the unit has malfunctioned and/or requires replacement (SPDs shall be provided with local visual indicators for the same diagnostics; UFC 3-520-01 Sections 3-4.1.1 and 3-4.1.2). SPD submittals shall include the manufacturer's recommended overcurrent protective device rating for the device(s) to be installed, and the circuit breaker ratings and conductor sizes shall be adjusted accordingly at no additional cost to the government.

Provide the following modes of protection:

FOR SINGLE PHASE AND THREE PHASE WYE CONNECTED SYSTEMS-
Phase to phase (L-L)
Each phase to neutral (L-N)
Neutral to ground (N-G)
Phase to ground (L-G)

FOR DELTA CONNECTIONS-
Phase to phase (L-L)
Phase to ground (L-G)

SPDs at the service entrance: provide with a minimum surge current rating of 80,000 amperes for L-L mode minimum and 40,000 amperes for other modes (L-N, L-G, and N-G) and downstream SPDs rated 40,000 amperes for L-L mode minimum and 20,000 amperes for other modes (L-N, L-G, and N-G).

Provide SPDs per NFPA 780 for the lightning protection system.

Maximum L-N, and N-G Voltage Protection Rating:

600V for 120V, single phase system
1,000V for 120/240V, single phase system
600V for 120/240V, three phase system
600V for 208Y/120V, three phase system
1,200V for 480Y/277V, three phase system

Maximum L-G Protection Rating:
700V for 120V, single phase system
1,000V for 120/240V, single phase system
700V for 120/240V, three phase system
700V for 208Y/120V, three phase system
1,200V for 480Y/277V, three phase system

Maximum L-L Voltage Protection Rating:

1,200V for 120/240V, three phase system
1,200V for 208Y/120V, three phase system
1,800V for 480Y/277V, three phase system

The minimum MCOV (Maximum Continuous Operating Voltage) rating for L-N and L-G modes of operation: 120 percent of nominal voltage for 240 volts and

below; 115 percent of nominal voltage above 240 volts to 480 volts.

Provide EMI/RFI filtering per UL 1283 for each mode with the capability to attenuate high frequency noise. Minimum attenuation: 20db.

2.31 FACTORY APPLIED FINISH

Provide factory-applied finish on electrical equipment in accordance with the following:

a. NEMA 250 corrosion-resistance test and the additional requirements as specified herein.

b. Interior and exterior steel surfaces of equipment enclosures: thoroughly cleaned followed by a rust-inhibitive phosphatizing or equivalent treatment prior to painting.

c. Exterior surfaces: free from holes, seams, dents, weld marks, loose scale or other imperfections.

d. Interior surfaces: receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice.

e. Exterior surfaces: primed, filled where necessary, and given not less than two coats baked enamel with semigloss finish.

f. Equipment located indoors: ANSI Light Gray, and equipment located outdoors: ANSI Light Gray.

g. Provide manufacturer's coatings for touch-up work and as specified in paragraph FIELD APPLIED PAINTING.

2.32 SOURCE QUALITY CONTROL

2.32.1 Transformer Factory Tests

2.32.1.1 Low- to Low-Voltage Transformer Factory Tests

Include routine NEMA ST 20 transformer test results on each transformer and also provide the results of NEMA "design" and "prototype" tests that were made on transformers electrically and mechanically equal to those specified.

2.32.1.2 Medium- to Low-Voltage Transformer Factory Tests

2.32.1.2.1 Design Tests

In accordance with IEEE C57.12.01 and IEEE C57.12.91. Additionally, IEEE C57.12.80 Section 5.1.2 states that "design tests are made only on representative apparatus of basically the same design." Submit design test reports in the same submittal package as the product data, shop drawings, and certificates of transformer losses for each of the specified transformers. Design tests must have been performed prior to the award of this contract.

Provide required submittals with index and tabs.

a. Tests must be certified and signed by a registered professional

engineer. Engineers stamp and signature must appear on at least the first page of the factory test reports.

b. Temperature rise: "Basically the same design" for the temperature rise test means a transformer with the same coil construction (such as wire wound primary and sheet wound secondary), the same kVA, the same cooling type, the same temperature rise rating, the same insulating class and the same insulating medium as the transformer specified.

Provide temperature rise readings, formulas, calculations of average temperature rise, and description of test method.

c. Lightning impulse: Basically the same design" for the lightning impulse dielectric test means a transformer with the same BIL and the same coil construction.

(1) IEEE C57.12.91 and IEEE C57.98. Provide design lightning impulse tests consisting of a reduced full-wave, two-chopped waves, and one full wave test for each phase of the primary and secondary windings of the same transformer.

(2) State test voltage levels.

d. Partial Discharge Test per IEEE C57.124. Provide transformer ratings, description and diagram of test method used, test readings and final results.

Routine and Other Tests

In accordance with IEEE C57.12.01 and IEEE C57.12.91. Routine and other tests must be performed by the manufacturer on each of the actual transformers prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Required tests and testing sequence must be as follows:

e. Resistance measurements

f. Phase relation

g. Ratio

h. Insulation power-factor by manufacturer's recommended test method

i. No-load losses (NLL) and excitation current

j. Load losses (LL) and impedance voltage

k. Lightning impulse: Perform the complete design type impulse tests on the transformer primary winding only.

(1) IEEE C57.12.91 and IEEE C57.98

(2) State test voltage levels

(3) Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test reports.

l. Low frequency dielectric

m. Applied voltage

n. Induced voltage

2.33 Conductor Termination Adapters

Pin adapters, reducers, lug kit adapters, pigtail adapters, and similar devices may be used for reduction from conductor size(s) larger than size(s) acceptable by terminals on equipment satisfying all other contract requirements.

Devices must be listed and compatible with the material with which interface occurs (i.e., copper conductors, aluminum busbars, etc.). Devices must not result in modification of equipment in or on which they are installed which results in compromise of the listing of the equipment nor of the manufacturer(s) warranty.

Products must be UL 486A-486B listed.

Crimp, compression, or mechanical/torque type adapters are permitted.

Adapters provided for insulated conductors (other than grounding electrode conductors, bonding jumpers, and equipment bonding conductors) shall be provided with an insulating cover. Adapters provided for bare conductors (and for grounding electrode conductors, bonding jumpers, and equipment bonding conductors) may omit an insulating cover.

Adapters must not be used to reduce conductor sizes below the maximum size permitted by the equipment, circuit breaker, etc., terminations in question requiring the adapters. Conductors must not be reduced in size smaller than required by ambient temperature and current-carrying conductor ampacity corrections and adjustments; utilize increased conductor insulation temperature rating as necessary.

2.34 Documentation of Terminations

All submittals for distribution equipment and disconnecting means on which conductors terminate (to include transformers, panelboards, switchboards, switchgear, variable frequency drives, enclosed circuit breakers, starters, disconnect switches, and similar) shall include conductor termination information to validate the suitability of equipment provided against the conductors required to satisfy voltage drop and ampacity adjustment/correction requirements.

2.35 Electrical System Accounting for Contractor-Furnished/Contractor-Installed (CFCI) Equipment and Devices:

While the Federal Acquisition Regulation (FAR) and Defense Federal Acquisition Regulation Supplement (DFARS) requirements prohibit the use of branch name (or equal) references in solicitations without a Justification and Approval for sole source procurement, equipment connection electrical properties (voltage, phase, amps, protection) included on the “Equipment Electrical Connection Schedule” are based on products available at the time of design and have been incorporated into the electrical distribution system included in the contract documents. The contractor must select equipment matching the electrical properties to the extent a deviation is not required for the sizes and configurations of the supply circuits and distribution equipment. Should any deviations be required, such changes

(including but not limited to conductor quantities, conductor sizes, protection size, protection poles, disconnect size, disconnect type, disconnect poles, supply equipment (panelboard, switchboard, switchgear, transformer) rating, and reperformance of power studies) shall be at no additional cost to the government, and any submittals approved which are impacted by such deviations must be re-submitted for approval incorporating the changes required to account for the deviations from the design conditions.

Equipment phase balancing of the load must be maintained to no greater than 5% imbalance while observing destination and routing grouping of circuits on the panelboards represented on the contact document panel schedules; exceptions to the 5% imbalance will be limited to lightly loaded or low circuit quantity panelboards (namely where already demonstrated in the contract documents to not satisfy this requirement) and instances where not practical from a circuit organization perspective (for example, see circuit organization on the panelboard(s) dedicated to telecommunication circuits) but maintaining an aggregated phase balance at upstream busses. Adjustments must maintain the spare space requirements, spare capacity requirements, conductor ampacity requirements, and voltage drop limits identified in UFCs 3-501-01 and 3-520-01, and shall re-account for fault contributions in the final establishment of withstand and interrupt ratings (and in turn, arc flash calculations and labeling).

This subpart is applicable to all electrical installation in the contract and not limited to the products listed in this individual specification section.

2.35.1 CFCI Equipment Electrical Data

Submit in tabular form all contractor-furnished/contractor-installed equipment requiring power connections shall be submitted at the same time as the supply equipment submittals and shall include the following:

(1) Equipment identifier on electrical plans
(2) Equipment type
(3) Approved Submittal Number (eg, 23 81 00.00 20-# for unitary air conditioning equipment)
(4) Manufacturer
(5) Model and Catalog Number
(6) Voltage
(7) Phase(s)
(8) Full-Load Amps (FLA)
(9) Minimum Circuit Ampacity (MCA)
(10) Manufacturer-Recommended Overcurrent Protection Device (MOCP)
(11) Minimum Disconnect Size

Inclusion of unapproved equipment will result in rejection of the CFCI and supply equipment submittals.

[*Am-00004] Include in the tabular form fields for voltage, phase(s), FLA, MCA, protection value, and disconnect size values identified in the contract documents for ease of comparison in review (note the protection values for circuit breakers are found on the panelboard, switchboard, and/or enclosed circuit breaker schedule(s), not on the Equipment Electrical Connection Schedule(s)). [**Am-00004] Identify in CFCI Equipment Electrical Data equipment with voltage, phase, FLA, MCA, and MOCP characteristics differing from the contract documents.

For CFCI equipment with multiple load components from a single building feed (for example: bridge cranes), provide the above data for the entire assembly with respect to the circuit supplied by the building (in addition to the protective elements for the individual components for the respective equipment's schematic diagram submittals).

Include equipment operating on 24V or similar characteristics utilizing step-down transformers local to the equipment but connected to the building distribution system. Items whose power is supplied from a control panel where the voltage is reduced below the aforementioned threshold need not be included, but the control panel interfacing with the electrical distribution system shall be included. [*Am-00004] In situations where the contract documents show line voltage supply for devices but the installed condition from the manufacturer requirements will be low voltage supply from a control panel, indicate explicitly in the CFCI Equipment Electrical Data submittal the specific control panel from which the device will be supplied.

Where circuits are adjusted due to approved differences in the installed condition from the conditions shown on the contract documents, adjust the circuit directories accordingly and identify in the associated submittals the description revisions to be made. For example, where line voltage supply is shown on the contract documents but the installed condition results in the devices supplied from a 24V control panel source, replace the circuit description with "SPARE" and maintain the existing circuit breaker. Similarly, where multi-circuit supplies are consolidated to a single circuit supply or vice versa due to manufacturer requirements, revise the circuit descriptions to couple or decouple the location and equipment identification, respectively, using a description conventions consistent with other circuits in the contract. Likewise, where multi-circuit supplies are consolidated to a single circuit supply due to manufacturer requirements, retain the vacated circuit breaker in the installed panel condition and revise the circuit description to "SPARE". [**Am-00004]
Include Surge Protective Devices (even though they have no load) in CFCI Equipment Electrical Data to track the MOCP and corresponding conductor requirements should they differ from the values assumed in the contract documents.
[*Am-00002]
Include all fire alarm circuits requiring power from the building electrical distribution system. This activity requires a substantially-developed fire alarm/etc. systems design; Coordinate across trades for timely delivery of this information.[**Am-00002]

Include Adjustable Speed/Variable Frequency Drives in CFCI Equipment Electrical Data to track circuit characteristics which may require adjustment in accordance with NFPA 70 Article 430 Part X.

Devices and equipment requiring building electrical distribution interface must adhere to the electrical configurations (phase/poles, voltage, etc.) identified by instance on the electrical plans and schedules.

Electrical System Contractor Variances for equipment shall be furnished at the time the Product Data is submitted and shall be comprehensive of all equipment seeking variance. Purchase and/or installation of equipment requiring an electrical variance prior to variance approval shall be at the risk to the contractor. Request for variance shall not assume approval of such variance. The electrical system connections have been coordinated with the basis of design equipment shown on the architectural,

interior design, fire protection, plumbing, mechanical, and/or electrical drawings. Should the equipment submitted for approval vary from the design equipment electrical needs and require a different connection than shown on the electrical plans, the contractor shall submit for approval revised schedules, plans, and diagrams indicating the changes to the electrical system due to the equipment variance based on the manufacturer-recommended minimum circuit ampacity (MCA) and maximum overcurrent protection (MOCP). The DOR reserves the right to increase conductor sizes above the manufacturer-required MCA due to ASHRAE 90.1 voltage drop and NFPA 70 derating/correction factors.

Circuit breakers shall be coordinated with deviation required by variances from the characteristics used in design as described in other specification sections and EP sheets. Where deviations are necessary, government approval is required. Deviations will be evaluated on the basis of load balancing by phase, maintaining spacial proximity, and system and equipment assignment; change in the votage will not be acceptable except in rare circumstances. Request for variance shall indicate the originating and final locations of all transplanted circuit breakers and the associated load names. Finally, circuit breakers for equipment requiring submission for approval are subject to change based on the manufacturer's MOCP of the submitted equipment, and the manufacturer's MOCP value shall be the value used for the protection device rating incorporated into related electrical protection device/equipment submittals and the installed condition. Incorporation of the final circuit breaker sizes into the distribution equipment is the responsibility of the contractor and are subject to approval through the submittal process. Circuit breaker sizes in the design documents shall not be assumed to be final for equipment provided in this contract and do not override the manufacturer's recommendations.

All equipment and devices must be properly rated for installation in the available fault current environment which exists at the location the equipment is installed. The contractor shall provide supplemental equipment features or fault current reduction measures where furnished equipment has a SCCR value less than the vault current available at the installed location where needed to satisfy this requirement.

Equipment and devices supporting CFCI equipment may be submitted for basic contract compliance review, but not for approval for installed equipment suitability without the associated data described herein.

2.35.2 Interim CFCI Equipment Electrical Data

The information required by the "CFCI Equipment Electrical Data" submittal may be furnished on an interim basis for inclusion of the partial set of the final data to support approval of related electrical distribution equipment (such as the data associated with a specific panelboard or set of panelboards). The data provided must be complete for the items included, to include identification of the submittal approving the equipment without a re-submittal required (that is, the submittal has received an "A" or "B" Action).

This item in the submittal registry is representative of any number of submittals the contractor wishes to produce for the purpose described in the preceding paragraph, and additional submittal registry entries may be created with unique names to facilitate the review and approval needs throughout the project life cycle prior to the approval of the comprehensive set of CFCI Equipment Electrical Data.

The following may be used for parts of the distribution system to facilitate equipment approval:

Interim CFCI Equipment Electrical Data (Fire Alarm)
For all equipment supplied by Section 28 31 70 Item: "Dedicated Emergency Panel Schedules".

Interim CFCI Equipment Electrical Data (Generator Station Service)
For all equipment supplied by panels GA1, GA2, GB1, and GB2 for generator loads requiring building power.

Interim CFCI Equipment Electrical Data (Filter Shelter)
For all equipment supplied by distribution equipment at the Filter Shelter (See EP604S, EP614S, EP632S, EP633S, and EP634S).

Interim CFCI Equipment Electrical Data (Offload)
For all equipment supplied by distribution equipment at the pumped offload (outside the Restricted Area fence; see EP603, EP613, EP631).

2.36 COORDINATED POWER SYSTEM PROTECTION

Prepare analyses as specified in Section 26 05 73 POWER SYSTEM STUDIES.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations, including weatherproof and hazardous locations and ducts, plenums and other air-handling spaces: conform to requirements of NFPA 70 and IEEE C2 and to requirements specified herein.

3.1.1 Underground Service

Underground service conductors and associated conduit: continuous from service entrance equipment to outdoor power system connection.

Encase the underground portion of the conduit in a concrete envelope and bury as specified for underground duct with concrete encasement.

3.1.2 Hazardous Locations

Perform work in hazardous locations, as defined by NFPA 70, in strict accordance with NFPA 70 for particular "Class," "Division," and "Group" of hazardous locations involved. Provide conduit and cable seals where required by NFPA 70. Provide conduit with tapered threads. Reference E-### series sheets for extent of hazardous area. Conductor and conduit sizes indicated on plans shall be considered minimum sizes.

3.1.2.1 Sealoffs

All conduits have been sized based on maximum 40 percent fill ratios and shall be considered minimum sizes. Provide sealoffs specifically identified and rated for 40 percent fill in accordance with the permission stated in NFPA 70 Section 501.15(C)(6). Sealoffs shall be inspectable and accessible.

3.1.3 Service Entrance Identification

Service entrance disconnect devices, switches, and enclosures: labeled and identified as such.

3.1.3.1 Labels

Wherever work results in service entrance disconnect devices in more than one enclosure, as permitted by NFPA 70, label each enclosure, new and existing, as one of several enclosures containing service entrance disconnect devices. Label, at minimum: indicate number of service disconnect devices housed by enclosure and indicate total number of enclosures that contain service disconnect devices. Provide laminated plastic labels conforming to paragraph FIELD FABRICATED NAMEPLATES. Use lettering of at least 0.25 inch in height, and engrave on black-on-white matte finish. Service entrance disconnect devices in more than one enclosure: provided only as permitted by NFPA 70.

3.1.4 Wiring Methods

Provide insulated conductors installed in rigid steel conduit, IMC, rigid nonmetallic conduit, or EMT, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Grounding conductor: separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s) installed in conduit and raceways. Shared neutral, or multi-wire branch circuits, are not permitted with arc-fault circuit interrupters. Minimum conduit size: 1/2 inch in diameter for low voltage lighting and power circuits. Vertical distribution in multiple story buildings: made with metal conduit in fire-rated shafts, with metal conduit extending through shafts for minimum distance of 6 inches. Firestop conduit which penetrates fire-rated walls, fire-rated partitions, or fire-rated floors in accordance with Section 07 84 00 FIRESTOPPING.

3.1.4.1 Prohibition on Shared Raceways for Circuits Supplied from Generator

Per UFC 3-540-01 Section 2-5.1, wiring from the generator to the loads served shall be kept entirely independent of all other general wiring unless otherwise permitted in NFPA 70 Article 700.

3.1.4.2 Pull Wire

Install pull wires in empty conduits. Pull wire: plastic having minimum 200-pound force tensile strength. Leave minimum 36 inches of slack at each end of pull wire.

3.1.4.3 Metal-Clad Cable

Install in accordance with NFPA 70, Type MC cable.

3.1.5 Adjustments for Unique Conductor Termination Applications

Note the equipment frame ratings on plans are identified in the schedule key to be minimum ratings, and larger frames (either for equipment or individual circuit breakers) will be required to terminate the conductors significantly increased in size for voltage drop (especially conductors associated with PHA and PHB) in accordance with the acceptable wire size and set ranges established by the manufacturer(s).

For feeders (other than panelboard-mounted circuit breakers for single-motor feeder applications) and service conductors, conductors must terminate without splicing directly on terminations provided by the equipment manufacturers or using a product described in Subpart "Conductor Termination Adapters." This shall also apply to terminations at disconnect switches, starters, combination starter/disconnects, and enclosed circuit breakers. Splices for the purpose of wire size reduction to land conductors on equipemnt terminations or adapters described are not acceptable.

For branch circuits and panelboard-mounted circuit breakers for single-motor feeder applications where adapters will not fit on devices at the point of termination, the total length of conductor to be reduced below the size adjusted to mitigate voltage drop must not exceed 10 feet or 10 percent of the circuit length, whichever is less. Provide the sizing information on the equipment directory (and O&M manual, where applicable) indicating differing conductor sizes along the circuit.

For conductors represented on the power studies where splices occur to reduce conductor sizes to land on terminations, model this size change accordingly in the power studies.

In applications where 200% neutral bus is indicated, if the equipment supplier needs to provide larger phase lugs and the new 100% bus would satisfy the original 200% bus, the new equipment does not need a 200% neutral as long as the conductors can suitably terminate on the new 100% bus lugs. In other words, provide a neutral bus with termination which will accommodate the conductors. For example, if the plans indicate a 100A mains with 200% neutral but requires conductors (for example: 3-3/0, 350kcmil N) exceeding the 100A mains buses' terminations (thus requiring a 225A or 400A frame), if the neutral conductor can land without reduction on thet 100% neutral bus of a size at least 200% the size of the original bus, the 100% neutral bus is acceptable on the larger equipment frame size.

3.1.6 Conduit Installation

Unless indicated otherwise, conceal conduit under floor slabs and within finished walls, ceilings, and floors. Exposed conduit is permissible in the generator bays, utility rooms, and unfinished spaces. Keep conduit minimum 6 inches away from parallel runs of flues and steam or hot water pipes. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project. Run conduits under floor slab as if exposed; do not install conduits routed horizontally on top of the floor.

Exterior building-mounted devices and equipment shall be wired from within the building and shall conform to the interior wiring standards described in this section to the greatest extent possible. No exterior building-mounted equipment and device circuits shall be surface mounted.

Conduits and associated support elements shall be coordinated with all other trades prior to installation. Installation resulting in interferences shall be resolved at no additional cost to the government. For example, conduits shall not be installed below door openings, including overhead coiling doors.

For entities shown at the roof level or mounted to the building exterior, even though the supporting infrastructure (such as junction boxes and

conduits) may be shown on outside the building, the raceways shall be interior to the building except where necessary to exit the building to supply the end devices unless otherwise noted.

See E-### series sheets regarding areas subject to physical damage.

3.1.6.1 Restrictions Applicable to Aluminum Conduit

a. Do not install underground or encase in concrete or masonry.

b. Do not use brass or bronze fittings.

3.1.6.2 Restrictions Applicable to EMT

a. Do not install underground.

b. Do not encase in concrete, mortar, grout, or other cementitious materials.

c. Do not use in areas subject to physical damage including but not limited to equipment rooms where moving or replacing equipment could physically damage the EMT.

d. Do not use in hazardous areas.

e. Do not use outdoors or in areas requiring wet ratings (see E-### series sheets).

f. Do not use in fire pump rooms.

g. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.6.3 Restrictions Applicable to Nonmetallic Conduit

a. PVC Schedule 40.

(1) Do not use where subject to physical damage, including but not limited to, mechanical equipment rooms, electrical equipment rooms, fire pump rooms, generator rooms, and where restrictions are applying to both PVC Schedule 40 and PVC Schedule 80.

(2) Do not use above grade, except where allowed in this section for rising through floor slab or indicated otherwise.

b. PVC Schedule 40 and Schedule 80.

(1) Do not use where subject to physical damage.

(2) Do not use in hazardous (classified) areas.

(3) Do not use in penetrating fire-rated walls or partitions, or fire-rated floors.

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3.1.6.4 Restrictions Applicable to Flexible Conduit

Use only as specified in paragraph FLEXIBLE CONNECTIONS.

3.1.6.5 Service Entrance Conduit, Underground

PVC, Type-EPC 40, galvanized rigid steel or steel IMC. Underground portion shall be encased in minimum of 3 inches of concrete and shall be installed minimum 18 inches below slab or grade.

3.1.6.6 Underground Conduit

Plastic-coated rigid steel; plastic-coated steel IMC; PVC, Type EPC-40. Convert nonmetallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid, or IMC, steel conduit before rising through floor slab. Plastic coating: extend minimum 6 inches above floor.

3.1.6.7 Conduit for Circuits Rated Greater Than 600 Volts

Rigid metal conduit or IMC only.

3.1.6.8 Conduit Installed Under Floor Slabs

Conduit run under floor slab: located a minimum of 12 inches below the vapor barrier. Seal around conduits at penetrations thru vapor barrier. Use NECA NEIS 1 Table 2a (Minimum Raceway Spacing) to determine under floor slab conduit spacing unless greater spacing is required elsewhere in this section.

To the greatest extent practical, route power distrubution system feeders underground and avoid routing through underground areas identified as Class I Division 1 (see E-### sheet series for these areas).

3.1.6.9 Conduit Through Floor Slabs

Where conduits rise through floor slabs, do not allow curved portion of bends to be visible above finished slab. Where conduit rises through slab-on grade, seal all electrical penetrations to address radon mitigation and prevent infiltration of air, insects, and vermin.

3.1.6.10 Conduit Installed in Concrete Floor Slabs

Rigid steel; steel IMC; fiberglass, or PVC, Type EPC-40.Locate so as not to adversely affect structural strength of slabs. Install conduit within middle one-third of concrete slab. Do not stack conduits more than two diameters high with minimum vertical separation of one inches. Space conduits horizontally not closer than three diameters, except at cabinet locations. Curved portions of bends must not be visible above finish slab. Increase slab thickness as necessary to provide minimum one inch cover over conduit. Where embedded conduits cross building expansion joints, provide suitable watertight expansion/deflection fittings and bonding jumpers. Expansion/deflection fittings must allow horizontal and vertical movement of raceway. Conduit larger than one inch trade size: installed parallel with or at right angles to main reinforcement; when at right angles to reinforcement, install conduit close to one of supports of slab. Where nonmetallic conduit is used, convert raceway to plastic coated rigid steel or plastic coated steel IMC before rising above floor, unless specifically indicated.

3.1.6.11 Stub-Ups

Provide conduits stubbed up through concrete floor for connection to free-standing equipment with adjustable top or coupling threaded inside

for plugs, set flush with finished floor. Extend conductors to equipment in rigid steel conduit, except that flexible metal conduit may be used 6 inches above floor. Where no equipment connections are made, install screwdriver-operated threaded flush plugs in conduit end.

3.1.6.12 Conduit Support

Support conduit by pipe straps, wall brackets, threaded rod conduit hangers, or ceiling trapeze. Plastic cable ties are not acceptable. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, welded threaded studs, or spring-tension clamps on steel work. Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Do not exceed one-fourth proof test load for load applied to fasteners. Provide vibration resistant and shock-resistant fasteners attached to concrete ceiling. Do not cut main reinforcing bars for any holes cut to depth of more than 1 1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete joints. Fill unused holes. In partitions of light steel construction, use sheet metal screws. In suspended-ceiling construction, run conduit above ceiling. Do not support conduit by ceiling support system. Conduit and box systems: supported independently of both (a) tie wires supporting ceiling grid system, and (b) ceiling grid system into which ceiling panels are placed. Do not share supporting means between electrical raceways and mechanical piping or ducts. Coordinate installation with above-ceiling mechanical systems to assure maximum accessibility to all systems. Spring-steel fasteners may be used for lighting branch circuit conduit supports in suspended ceilings in dry locations. Support exposed risers in wire shafts of multistory buildings by U-clamp hangers at each floor level and at 10 foot maximum intervals. Where conduit crosses building expansion joints, provide suitable watertight expansion fitting that maintains conduit electrical continuity by bonding jumpers or other means. For conduits greater than 2 1/2 inches inside diameter, provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.6.13 Directional Changes in Conduit Runs

Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits. Avoid trapped conduits. Prevent plaster, dirt, or trash from lodging in conduits, boxes, fittings, and equipment during construction. Free clogged conduits of obstructions.

3.1.6.14 Locknuts and Bushings

Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use at least minimum single locknut and bushing. Provide locknuts with sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by NFPA 70.

3.1.6.15 Flexible Connections

Provide flexible steel conduit between 3 and 6 feet in length for recessed and semirecessed lighting fixtures; for equipment subject to vibration,

noise transmission, or movement; and for motors; and for equipment explicitly indicated on the drawings. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size: 1/2 inch diameter. Provide liquid tight flexible nonmetallic conduit in wet and damp locations (see E-### series sheets) and in fire pump rooms for equipment subject to vibration, noise transmission, movement or motors. Provide separate ground conductor across flexible connections. Plastic cable ties are not acceptable as a support method.

3.1.6.16 Telecommunications and Signal System Pathway

Install telecommunications pathway in accordance with TIA-569.

Cable trays, conduits, and associated support elements shall be coordinated with all other trades prior to installation. Installation resulting in interferences shall be resolved at no additional cost to the government. For example, cable trays and conduits shall not be installed below door openings, including overhead coiling doors.

a. Horizontal Pathway: Telecommunications pathways from the work area to the telecommunications room: installed and cabling length requirements in accordance with TIA-568.1. Size conduits, wireways, and cable trays in accordance with TIA-569 and as indicated.

b. Backbone Pathway: Telecommunication pathways from the telecommunications entrance facility to telecommunications rooms, and, telecommunications equipment rooms (backbone cabling): installed in accordance with TIA-569. Size conduits, wireways, and cable trays for telecommunications risers in accordance with TIA-569 and as indicated.

3.1.6.17 Areas Subject to Severe Physical Damage

See sheet E-120 and E-100S.

3.1.7 Busway Installation

Comply at minimum with NFPA 70. Install busways parallel with or at right angles to ceilings, walls, and structural members. Support busways at 5 foot maximum intervals, and brace to prevent lateral movement. Provide fixed type hinges on risers; spring-type are unacceptable. Provide flanges where busway makes penetrations through walls and floors, and seal to maintain smoke and fire ratings. Provide waterproof curb where busway riser passes through floor. Seal gaps with fire-rated foam and caulk. Provide expansion joints, but only where bus duct crosses building expansion joints. Provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.8 Cable Tray Installation

Install and ground in accordance with NFPA 70. In addition, install and ground telecommunications cable tray in accordance with TIA-569 and TIA-607. Install cable trays parallel with or at right angles to ceilings, walls, and structural members. Cable tray and tray supports must not partially nor completely obstruct access to the room. Support in accordance with manufacturer recommendations but at not more than 6 foot intervals. Coat contact surfaces of aluminum connections with an antioxidant compound prior to assembly. Adjacent cable tray sections: bonded together by connector plates of an identical type as the cable tray sections. For

grounding of cable tray system provide No. 2 AWG bare copper wire throughout cable tray system, and bond to each section, except use No. 1/0 aluminum wire if cable tray is aluminum. Terminate cable trays 10 inches from both sides of smoke and fire partitions. Install conductors run through smoke and fire partitions in 4 inch rigid steel conduits with grounding bushings, extending 12 inches beyond each side of partitions. Seal conduit on both ends to maintain smoke and fire ratings of partitions. Firestop penetrations in accordance with Section 07 84 00, FIRESTOPPING. Provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.9 Boxes, Outlets, and Supports

Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways: cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces, when surface mounted on interior walls exposed up to the greater height of 7 feet above floors and walkways or the height of "areas subject to physical damage", or when installed in hazardous areas, and when specifically indicated. Boxes in other locations: sheet steel, except that aluminum boxes may be used with aluminum conduit, and nonmetallic boxes may be used with nonmetallic conduit system. Provide each box with volume required by NFPA 70 for number of conductors enclosed in box. Boxes for mounting lighting fixtures: minimum 4 inches square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved. Boxes for use in masonry-block or tile walls: square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers. Provide gaskets for cast-metal boxes installed in wet locations and boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature. Provide access panels in gypsum ceilings to reach junction boxes; coordinate with other trades such that opening provides unimpeded access to device to be maintained (i.e., opening is not directly below ductwork or cable tray).Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports. Fasten boxes and supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel. In open overhead spaces, cast boxes threaded to raceways need not be separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers. Where bar hangers are used, attach bar to raceways on opposite sides of box, and support raceway with approved-type fastener maximum 24 inches from box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.

3.1.9.1 Boxes

Boxes for use with raceway systems: minimum 1 1/2 inches deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets: minimum 4 inches square, except that 4 by 2 inch boxes may be used where only one raceway enters outlet. Telecommunications outlets: a minimum of 4 11/16 inches square by 2 1/8 inches deep, except for wall-mounted telephones (see Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEMS). Mount outlet boxes flush in finished walls in finished spaces.

3.1.9.2 Pull Boxes

Construct of at least minimum size required by NFPA 70 of code-gauge aluminum or galvanized sheet steel, except where cast-metal boxes are required in locations specified herein. Provide boxes with screw-fastened covers. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit numbers, and panel designations.

3.1.9.3 Extension Rings

Extension rings are not permitted for new construction.

3.1.10 Mounting Heights

Mount panelboards, enclosed circuit breakers, motor controller and disconnecting switches so height of center of grip of the operating handle of the switch or circuit breaker at its highest position is maximum 79 inches above floor or working platform or as allowed in Section 404.8 per NFPA 70. Mount lighting switches, receptacles, telecommunications outlets, and other devices as indicated on mounting height detail sheet.

3.1.11 Conductor Identification

Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No. 6 AWG and smaller diameter, provide color coding by factory-applied, color-impregnated insulation. For conductors No. 4 AWG and larger diameter, provide color coding by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves. Identify control circuit terminations in accordance with Division 23 Specification Sections. Provide telecommunications system conductor identification as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEMS.

3.1.11.1 Marking Strips

Provide marking strips for identification of power distribution, control, data, and communications cables in accordance with the following:

a. Provide white or other light-colored plastic marking strips, fastened by screws to each terminal block, for wire designations.

b. Use permanent ink for the wire numbers

c. Provide reversible marking strips to permit marking both sides, or provide two marking strips with each block.

d. Size marking strips to accommodate the two sets of wire numbers.

e. Assign a device designation in accordance with NEMA ICS 1 to each device to which a connection is made. Mark each device terminal to which a connection is made with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams.

f. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, provide additional wire and cable designations for identification of remote (external)

circuits for the Government's wire designations.

g. Prints of the marking strips drawings submitted for approval will be so marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

3.1.12 Splices

Make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make splices in conductors No. 8 AWG and larger diameter with solderless connector, and cover with insulation material equivalent to conductor insulation.

3.1.12.1 Splices of Aluminum Conductors

Make with solderless circumferential compression-type, aluminum-bodied connectors UL listed for AL/CU. Remove surface oxides from aluminum conductors by wire brushing and immediately apply oxide-inhibiting joint compound and insert in connector. After joint is made, wipe away excess joint compound, and insulate splice.

3.1.13 Covers and Device Plates

Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Install plates with alignment tolerance of 1/16 inch. Use of sectional-type device plates are not permitted. Provide gasket for plates installed in wet locations.

3.1.14 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated walls, partitions, floors, or ceilings in accordance with Section 07 84 00 FIRESTOPPING.

3.1.15 Grounding and Bonding

Provide in accordance with NFPA 70 and NFPA 780. Ground exposed, non-current-carrying metallic parts of electrical equipment, access flooring support system, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, telecommunications system grounds, underground storage tanks and pipelines (see Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS), and neutral conductor of wiring systems. Make ground connection at main service equipment, and extend grounding conductor to point of entrance of metallic water service. Make connection to water pipe by suitable ground clamp or lug connection to plugged tee. If flanged pipes are encountered, make connection with lug bolted to street side of flanged connection. Supplement metallic water service grounding system with additional made electrode in compliance with NFPA 70. Make ground connection to driven ground rods on exterior of building. Bond additional driven rods together with a minimum of 4 AWG soft bare copper wire buried to a depth of at least 12 inches. Interconnect all grounding media in or on the structure to provide a common ground potential. This includes lightning protection, electrical service, telecommunications system grounds, as well as underground metallic piping systems. Make interconnection to the gas line on the customer's side of the meter. Reference EG600 for minimum conductor

sizing requirements. Use main size lightning conductors for interconnecting these grounding systems to the lightning protection system. In addition to the requirements specified herein, provide telecommunications grounding in accordance with TIA-607. Where ground fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection.

3.1.15.1 Ground Rods

Provide ground rods and measure the resistance to ground using the fall-of-potential method described in IEEE 81. Do not exceed 25 ohms under normally dry conditions for the maximum resistance of a driven ground. If this resistance cannot be obtained with a single rod, additional rods, spaced on center. Spacing for additional rods must be a minimum of 10 feet. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Contracting Officer who will decide on the number of ground rods to add.

3.1.15.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible, excepting specifically those connections for which access for periodic testing is required, by exothermic weld or high compression connector.

a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.

b. Make high compression connections using a hydraulic or electric compression tool to provide the correct circumferential pressure. Provide tools and dies as recommended by the manufacturer. Use an embossing die code or other standard method to provide visible indication that a connector has been adequately compressed on the ground wire.

3.1.15.3 Ground Bus

Provide a copper ground bus in the electrical equipment rooms as indicated. Noncurrent-carrying metal parts of transformer neutrals and other electrical equipment: effectively grounded by bonding to the ground bus. Bond the ground bus to both the entrance ground, and to a ground rod or rods as specified above having the upper ends terminating approximately 4 inches above the floor. Make connections and splices of the brazed, welded, bolted, or pressure-connector type, except use pressure connectors or bolted connections for connections to removable equipment.

3.1.15.4 Resistance

Maximum resistance-to-ground of grounding system: do not exceed 5 ohms under dry conditions. Where resistance obtained exceeds 5 ohms, contact Contracting Officer for further instructions.

3.1.15.5 Telecommunications System

Provide telecommunications grounding in accordance with the following:

a. Telecommunications Grounding Busbars: Provide a Primary bonding busbar (TGB) in the telecommunications entrance facility. Install the TGB as close to the electrical service entrance grounding connection as practicable. .

1. Connectors: Mechanical type, cast silicon bronze, solderless compression type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide with 9/32-inch holes spaced 1-1/8 inches apart.

3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

b. Telecommunications Bonding Conductors: Provide main telecommunications service equipment ground consisting of separate bonding conductor for telecommunications, between the TGB and readily accessible grounding connection of the electrical service. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 3 feet in length, bond the conductors to each end of the conduit using a grounding bushing or a No. 6 AWG conductor, minimum.

c. Telecommunications Grounding Connections: Telecommunications grounding connections to the TGB: utilize listed compression two-hole lugs, exothermic welding, suitable and equivalent one hole non-twisting lugs, or other irreversible compression type connections. Bond all metallic pathways, cabinets, and racks for telecommunications cabling and interconnecting hardware located within the same room or space as the TGB to the TGB. In a metal frame (structural steel) building, where the steel framework is readily accessible within the room; bond each TGB to the vertical steel metal frame using a minimum No. 6 AWG conductor. Where the metal frame is external to the room and readily accessible, bond the metal frame to the TGB with a minimum No. 6 AWG conductor. When practicable because of shorter distances and, where horizontal steel members are permanently electrically bonded to vertical column members, the TGB may be bonded to these horizontal members in lieu of the vertical column members. All connectors used for bonding to the metal frame of a building must be listed for the intended purpose.

d. Comply with TIA-607.

3.1.16 Equipment Connections

Provide power wiring for the connection of motors and control equipment under this section of the specification. Except as otherwise specifically noted or specified, automatic control wiring, control devices, and protective devices within the control circuitry are not included in this section of the specifications and are provided under the section specifying the associated equipment.

3.1.17 Government-Furnished Equipment

Contractor rough-in for Government-furnished equipment make connections to Government-furnished equipment to make equipment operate as intended, including providing miscellaneous items such as plugs, receptacles, wire,

cable, conduit, flexible conduit, and outlet boxes or fittings; except the contractor shall make final connections to Government-furnished systems furniture.

3.1.18 Surge Protective Devices

Connect the surge protective devices in parallel to the power source, keeping the conductors as short and straight as practically possible. Maximum allowed lead length is 3 feet avoiding 90 degree bends. Do not locate surge protective devices inside a panelboard or switchboard enclosure.

3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with NFPA 70E.

3.3.1 Remote Disconnecting Means Placards

For equipment with remote and/or lockable disconnecting means, provide a placard indicating the location of the disconnecting means.

3.4 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting: as specified in Section 09 90 00 PAINTS AND COATINGS.Where field painting of enclosures for panelboards, load centers or the like is specified to match adjacent surfaces, to correct damage to the manufacturer's factory applied coatings, or to meet the indicated or specified safety criteria, provide manufacturer's recommended coatings and apply in accordance to manufacturer's instructions.

3.5 FIELD QUALITY CONTROL

Furnish test equipment and personnel and submit written copies of test results. Give Contracting Officer 5 working days notice prior to each test. Where applicable, test electrical equipment in accordance with NETA ATS.

3.5.1 Devices Subject to Manual Operation

Operate each device subject to manual operation at least five times, demonstrating satisfactory operation each time.

3.5.2 600-Volt Wiring Test

Test wiring rated 600 volt and less to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of 1,000 volts DC for 600 volt rated wiring and 500 volts DC for 300 volt rated wiring per NETA ATS to provide direct reading of resistance. All existing wiring to be reused must also be tested.

3.5.3 Transformer Tests

3.5.3.1 Low- to Low-Voltage Transformer Tests

Perform the standard, not optional, tests in accordance with the Inspection and Test Procedures for transformers, dry type, air-cooled, 600 volt and below; as specified in NETA ATS. Measure primary and secondary voltages for proper tap settings. Tests need not be performed by a recognized independent testing firm or independent electrical consulting firm.

3.5.3.2 Medium- to Low-Voltage Transformer Tests

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate information with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(4) Perform specific inspections and mechanical tests as recommended by manufacturer.

(5) Verify that resilient mounts are free and shipping brackets have been removed.

(6) Verify that winding core, frame, and enclosure groundings are correct.

(7) Verify that as-left tap connections are as specified.

b. Electrical Tests

(1) Perform insulation-resistance tests.

(2) Perform power-factor tests or dissipation-factor tests in accordance with the test equipment manufacturer's instructions.

(3) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

(4) Perform turns-ratio tests.

(5) Perform an applied-voltage test on high and low voltage windings-to-ground. See IEEE C57.12.91. The ac dielectric-withstand-voltage test result must not exceed 75 percent of factory test voltage for one-minute duration. The dc dielectric-withstand-voltage test result must not exceed 100 percent of the ac rms test voltage specified in IEEE C57.12.91 for a one-minute duration. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.

(6) Verify correct secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

3.5.4 Ground-Fault Receptacle Test

Test ground-fault receptacles with a "load" (such as a plug in light) to verify that the "line" and "load" leads are not reversed. Press the TEST button and then the RESET button to verify by LED status that the device is a self-test model as specified in UL 943.

3.5.5 Arc-Fault Receptacle Test

Test arc-fault receptacles with a "load" (such as a plug in light) to verify that the "line" and "load" leads are not reversed. Press the TEST button and then the RESET button to verify by LED status that the device is a self-test model as specified in UL 1699.

3.5.6 Grounding System Test

Test grounding system to ensure continuity, and that resistance to ground is not excessive. Test each ground rod for resistance to ground before making connections to rod; tie grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test to Contracting Officer, and indicate location of rods as well as resistance and soil conditions at time measurements were made.

3.5.7 Phase Rotation Test

Perform phase rotation test to ensure proper rotation of service power prior to operation of new or reinstalled equipment using a phase rotation meter. Follow the meter manual directions performing the test.

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SECTION 31 00 00

EARTHWORK
08/23

PART 1 GENERAL

[*Am-4]

Attachment - Geotechnical Engineering Report - For Information Only [**Am-4]

1.1 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(2017) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C600	(2017) Installation of Ductile-Iron Mains and Their Appurtenances

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M	(2023) Standard Specification for Concrete Aggregates
ASTM C117	(2017) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C150/C150M	(2022) Standard Specification for Portland Cement
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989/C989M	(2022) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM D1140	(2017) Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by

	Washing
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2167	(2015) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2321	(2020) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D4253	(2016; E 2019) Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D4254	(2016) Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4832	(2016; E 2018) Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders
ASTM D5268	(2019) Topsoil Used for Landscaping Purposes
ASTM D6023	(2016) Standard Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material (CLSM)
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

U.S. ARMY CORPS OF ENGINEERS (USACE)

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

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600/4-79/020	(1983) Methods for Chemical Analysis of Water and Wastes
EPA SW-846.3-3	(1999, Third Edition, Update III-A) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods

1.2 DEFINITIONS

1.2.1 Structural Fill

Soil material placed to support buildings, walls, pads, and other similar facilities.

1.2.2 Embankment Fill

Soil material placed to construct embankment.

1.2.3 Porous Fill

Free-draining material placed for subsurface drainage, as a capillary break, or another specific purpose. See also Capillary Water Barrier.

1.2.4 Topsoil

Surface layer of primarily organic soil capable of supporting vegetation growth.

1.2.5 Utility Bedding Material

Fill placed to directly support pipes, conduits, cables, and appurtenant structures. Bedding may also be used to provide a cushion between utilities and bedrock, obstacles, obstructions and other unyielding materials.

1.2.6 Flowable Fill

Fill placed in a plastic or liquid form that flows to near its final placement location with limited assistance and subsequently cures or solidifies to provide a stable or impermeable barrier.

1.2.7 Satisfactory Materials

Satisfactory materials for fill, backfill, and/or any in-situ soils to remain in place comprise any materials classified by ASTM D2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, SM, SW-SM, SC,SW-SC, SP-SM, SP-SC, CL, and CL-ML. Maximum particle size to be no greater than 3 inches in any dimension.

1.2.8 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; roots and other organic matter or frozen material. Notify the Contracting Officer when encountering any contaminated materials.

1.2.9 Cohesionless Materials

Cohesionless materials include materials classified in ASTM D2487 as GW, GP, SW, and SP. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic. Perform testing, required for classifying materials, in accordance with ASTM D4318, ASTM C117, ASTM C136/C136M and ASTM D1140.

1.2.10 Cohesive Materials

Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesive only when the fines are plastic. Perform testing, required for classifying materials, in accordance with ASTM D4318, ASTM C117, ASTM C136/C136M and ASTM D1140.

1.2.11 Hard/Unyielding Materials

Hard/Unyielding materials comprise weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock" with stones greater than 12 inch in any dimension or as defined by the pipe manufacturer, whichever is smaller. These materials usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

1.2.12 Unstable Material

Unstable materials are too weak to adequately support the utility pipe, conduit, equipment, or appurtenant structure. Satisfactory material may become unstable due to ineffective drainage, dewatering, becoming frozen, excessive loading.

1.2.13 Expansive Soils

Expansive soils are defined as soils that have a plasticity index greater than 20 when tested in accordance with ASTM D4318.

1.2.14 Rock

Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement exceeding 1/2 cubic yard in volume. Removal of hard material will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

1.2.15 Capillary Water Barrier

A layer of clean, poorly graded crushed rock, stone, or natural sand or gravel having a high porosity which is placed beneath a building slab with or without a vapor barrier to cut off the capillary flow of pore water to the area immediately below a slab. See also Porous Fill.

1.2.16 Degree of Compaction (Proctor)

Degree of compaction required, except as noted in the second sentence, is

expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D1557 abbreviated as a percent of laboratory maximum density. Since ASTM D1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, express the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve as a percentage of the maximum density in accordance with AASHTO T 180-21 paragraph 1.5, Note 1.

1.2.17 Degree of Compaction (Relative Density)

Degree of compaction required for soils with less than 5 percent passing the No. 200 sieve, is expressed as a relative percentage of the maximum index density/dry unit weight and minimum index density/dry unit weight, obtained by the test procedures in accordance with ASTM D4253 and ASTM D4254, respectively, abbreviated as a percent of laboratory relative density.

1.2.18 Borrow

Soil brought to the project site from an external location for the purposes of project construction.

1.2.19 Subgrade

Earth materials directly below foundations and directly below granular base materials in building slab and pavement areas including shoulders.

1.3 SUBSURFACE DATA

Subsurface soil boring logs are shown in project plans. These data represent available subsurface information; however, variations may exist between boring locations.

1.4 CRITERIA FOR BIDDING

Base bids on the following criteria:

a. Surface elevations are as indicated.

b. Pipes or other artificial obstructions, except those indicated, will not be encountered.

c. Ground water elevations indicated by the boring log were those existing at the time subsurface investigations were made and do not necessarily represent ground water elevation at the time of construction.

d. Material character is indicated by the boring logs.

f. Hard materials will not be encountered.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Excavation and Trenching Plan; G, RO

Dewatering Work Plan; G, RO

Disposition of Surplus Materials; G, RO

Preconstruction Meeting; G, RO

SD-03 Product Data

Flowable Fill Mix Design; G, RO

Geotextiles

SD-04 Samples

Geotextiles

SD-06 Test Reports

Borrow Site Testing; G, RO

Pipe Inspection Report; G, RO

Material Test Reports; G, RO

1.6 QUALITY CONTROL

1.6.1 Geotechnical Engineer

Provide a Professional Geotechnical Engineer to provide inspection of excavations and soil/groundwater conditions throughout construction. The Geotechnical Engineer is responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The Geotechnical Engineer is responsible for preparing and updating the Excavation and Trenching Plan and Dewatering Work Plan as construction progresses to reflect changing conditions and submit an updated plan if necessary. The Contractor is responsible for arranging meetings with the Geotechnical Engineer and Contracting Officer throughout the contract duration.

1.6.2 Qualified Technician

Provide a Qualified Technician to inspect, monitor, sample, and performing field testing. The technician qualifications need to be one of the following: a current National Institute for Certification in Engineering Technologies (NICET) Level II minimum certification in Construction Materials Testing Soils; a Geologist-in-Training with minimum one-year experience; an Engineer-in-Training with minimum one-year experience; a Registered Geologist; or a Professional Engineer.

1.6.3 Lab Validation

Perform testing by a Corps validated commercial testing laboratory or

Contractor established testing laboratory meeting the requirements of Section 01 45 00 (or similar number) entitled QUALITY CONTROL and approved by the Contracting Officer. Submit testing laboratory validation for the testing to be performed. Do not permit work requiring testing until testing facilities have been inspected, Corps validated and approved by the Contracting Officer.

1.6.4 Preconstruction Meeting

Conduct a preconstruction meeting at the jobsite at least five business days prior to the start of earthwork operations on the project. The preconstruction meeting is to be arranged by the Contractor and is to follow the written agenda submitted prior to the meeting. The purpose of this meeting is to review the requirements of this specification and the associated plans. The following individuals must be in attendance at this meeting: Contractor's Project Manager and Project Superintendent, earthwork subcontractor's Project Manager and Site Foreman, Contractor's Geotechnical Engineer and Testing Agency, Government Engineer, and Government Construction Manager and Engineering Technician.

The minutes of this meeting are to be recorded by the Contractor and published via email within 48 hours to all attendees. The minutes must be re-published within 48 hours via email pending any subsequent comments from the attendees.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

2.1.1 Structural Fill

Materials classified as SM, SC, or CL in accordance with ASTM D2487. Select material type appropriate for the intended purpose.

2.1.2 Porous Fill

Materials containing less than 5 percent passing the No. 200 sieve. Provide the gradation as appropriate for the intended purpose.

2.1.3 Topsoil

Material suitable for topsoil obtained from areas indicated on the drawings is defined as: Natural, friable soil representative of productive, well-drained soils in the area, free of subsoil, stumps, rocks larger than one inch diameter, brush, weeds, toxic substances, and other material detrimental to plant growth. Topsoil material will be in accordance with ASTM D5268.

2.1.4 Capillary Water Barrier

Conform to ASTM C33/C33M for fine aggregate grading with Poorly-graded crushed stone or gravel with 100% passing the 1½-inch sieve and less than 5% passing the No. 200 sieve. .

2.1.5 Utility Bedding Material

Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600 or ASTM D2321. Install bedding for plastic piping to spring line of pipe. Utility

bedding material may include the following:

2.1.5.1 Class I

Angular, 0.25 to 1.5 inch, graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.

2.1.5.2 Class II

Coarse sands and gravels with maximum particle size of 1.5 inch, including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D2487.

2.1.5.3 Sand

Clean, coarse-grained sand classified as SW or SP by ASTM D2487 for bedding and backfill as indicated.

2.1.5.4 Gravel and Crushed Stone

Clean, coarsely graded natural gravel, crushed stone or a combination thereof identified as GW or GP in accordance with ASTM D2487 for bedding and backfill as indicated.

2.2 FLOWABLE FILL

Design and submit flowable fill mix design to consist of Portland cement, fly ash, and/or slag cement and fine aggregate. Include the dry weights of cementitious material(s); quality and gradation of aggregates in the saturated surface-dry weights along with gradation tests; quantities, types, and names of admixtures; and quantity of water per cubic yard. The maximum unconfined compressive strength to be 300 psi at 28 days in accordance with ASTM D4832. The aggregates in accordance with ASTM C33/C33M Fine Aggregates. Air-entrain fill in accordance with ASTM C260/C260M. The air content to be between 8 and 15 percent in accordance with ASTM D6023. Portland cement to be Type I or II in accordance with ASTM C150/C150M. Fly ash to be Class C in accordance with ASTM C618. Provide slag cement in Grade 100 or 120 in accordance with ASTM C989/C989M.

2.3 BURIED WARNING AND IDENTIFICATION MARKERS

Provide polyethylene plastic and metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3 inches minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Provide permanent color and printing, unaffected by moisture or soil.

Warning Tape Color Codes	
Red	Electric
Yellow	Gas, Oil; Dangerous Materials
Orange	Telephone and Other Communications
Blue	Water Systems
Green	Sewer Systems
White	Steam Systems
Gray	Compressed Air

2.3.1 Warning Tape for Metallic Piping

Provide acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.003 inch and a minimum strength of 1500 psi lengthwise, and 1250 psi crosswise, with a maximum 350 percent elongation.

2.3.2 Detectable Warning Tape for Non-Metallic Piping

Provide polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.004 inch, and a minimum strength of 1500 psi lengthwise and 1250 psi crosswise. Manufacture tape with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 3 feet deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

2.3.3 Detection Wire for Non-Metallic Piping

Insulate a single strand, solid copper detection wire with a minimum of 12 AWG.

2.4 MATERIAL FOR RIP-RAP

Providegeotextile and rock conforming to the 2023 Colorado DOT Specifications for construction indicated.

2.5 BORROW

Provide borrow materials from sources located outside of Government property meeting the requirements of paragraph STRUCTURAL FILL, EMBANKMENT FILL and TOPSOIL.

2.6 GEOTEXTILE

Provide a pervious sheet of nonwoven polyester, nylon, glass or polypropylene ultraviolet resistant filaments, spun bonded, fused, or otherwise manufactured into a non-raveling fabric with uniform thickness and strength. Fabric must have manufacturer certified minimum average roll properties that conform with AASHTO M288 Class 3 Geotextile. Submit a sample and material product data for all Geotextiles utilized.

PART 3 EXECUTION

3.1 PROTECTION

Perform all work specified in accordance with applicable requirements of the Corps of Engineers publication EM 385-1-1 Safety and Health Requirements Manual. Provide a Geotechnical Engineer to monitor construction activities and to prepare necessary work plans and reports; see paragraph QUALITY CONTROL.

Use equipment of type and size appropriate for the site conditions (soil character and moisture content). Maintenance of exposed subgrades and fills is the responsibility of the Contractor. The Contractor is required to prevent damage by ineffective drainage, dewatering, and heavy loads and equipment by implementing precautionary measures. Repair or replace any defects or damage.

3.1.1 Underground Utilities

Location of the existing utilities indicated is approximate. Physically verify the location and elevation of the existing utilities indicated prior to starting construction. The Contractor is responsible for protecting utilities from damage during construction.

3.1.2 Drainage and Dewatering

Provide for the collection and disposal of surface and subsurface water encountered during construction.

3.1.2.1 Drainage

Provide for the collection and disposal of surface and subsurface water encountered during construction. Construct storm drainage features (ponds/basins) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity and provide temporary ditches, swales, and other drainage features and equipment as required to keep soils from becoming unstable, prevent erosion, or undermining of foundations. Remove unstable material from working platforms for equipment operation and soil support for subsequent construction features and provide new material as specified herein. It is the responsibility of the Contractor to assess the site conditions to employ necessary measures to permit construction to proceed.

3.1.2.2 Dewatering

Control groundwater flowing toward or into excavations to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. French drains, sumps, ditches or trenches are not allowed within 3 feet of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Perform control measures by the time the excavation reaches the water level in order to maintain the integrity of the in-situ material. While the excavation is open, maintain the water level continuously, at least 2 feet below the working level. Submit a Dewatering Work Plan outlining procedures for accomplishing dewatering work, if necessary.

3.1.3 Shoring and Sheeting

Submit an Excavation and Trenching Plan to stabilize features, prevent undermining or unintended horizontal and vertical movement of adjacent structures, and prevent slippage or movement in banks or slopes adjacent to the excavation. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheeting of excavations. Drawings to include material sizes and types, arrangement of members, and the sequence and method of installation and removal. Calculations are to include data and references used.

3.1.4 Protection of Graded Surfaces

Protect newly backfilled, graded, and topsoiled areas from traffic, erosion, and settlements that may occur. Repair or reestablish damaged grades, elevations, or slopes.

3.2 BORROW

Select borrow material to meet the requirements and conditions of the fill for which it is to be used. Obtain borrow material from from approved private sources. Unless otherwise provided in the contract, the Contractor is responsible for obtaining the right to procure material, pay royalties and other charges involved, and bear the expense of developing the sources, including rights-of-way for hauling from the owners. Unless specifically provided, do not obtain borrow within the limits of the project site without prior written approval.

3.2.1 Contractor Furnished Borrow Area(s)

Obtain approved borrow materials from approved offsite sources. If a borrow source is selected that is not a commercial entity from which soil material is directly purchased, submit a Borrow Plan that includes the borrow source location, geotechnical test results showing the fill material meets the Contract requirements, environmental test results in accordance with paragraph ENVIRONMENTAL REQUIREMENTS FOR OFF-SITE SOIL, and any Federal, State, and local permits required for excavation and reclamation of the borrow area.

3.2.2 Environmental Requirements for Off-Site Soil

Test offsite soils brought in for use as backfill for PFAS in accordance with Method 1633.
Test offsite soils brought in for use as backfill for Total Petroleum Hydrocarbons (TPH), Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and full Toxicity Characteristic Leaching Procedure (TCLP) including ignitability, corrosivity and reactivity. Backfill shall contain amaximum of 100 parts per million (ppm) of total petroleum hydrocarbons (TPH) and a maximum of 10 ppm of the sum of Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and shall pass the TCPL test. Determine TPH concentrations by using EPA 600/4-79/020 Method 418.1. Determine BTEX concentrations by using EPA SW-846.3-3 Method 5030/8020/8260B. Perform TCLP in accordance with EPA SW-846.3-3 Method 1311. Perform hazardous waste characteristic tests for ignitability, corrosivity, and reactivity in accordance with accepted standard methods. Perform PCB testing in accordance with accepted standard methods for sampling and analysis of bulk solid samples. Provide borrow site testing for TPH, BTEX and TCLP from a

composite sample of material from the borrow site, with at least one test from each borrow site. Do not bring material onsite until tests have been approved by the Contracting Officer.
Submit Test reports prior to soil import.

3.3 SURFACE PREPARATION

3.3.1 Clearing and Grubbing

Remove trees, stumps, logs, shrubs, brush and vegetation and other items that would interfere with construction operations. Remove stumps entirely. Grub out matted roots and roots over 3 inches in diameter to at least 18 inches below existing surface.

3.3.2 Stripping

Strip site where indicated on the plans. Strip existing surface materials and soils to a depth of 6 inches below the existing subgrade surface in all areas. Strip in all areas within the planned limits of disturbance. All stripped materials not suitable for reuse as topsoil will be wasted in specified disposal area. Screen all stripped soils to remove roots and organic materials prior disposal.

3.3.3 Proof Rolling

Perform proof rolling on exposed subgrade that is unfrozen and free of surface water (wet conditions resulting from rainfall).Notify the Contracting Officer a minimum of three days prior to proof rolling. Perform proof rolling in the presence of the Contracting Officer.

After stripping, excavating, and rough grading to the planned elevation, proof roll the existing subgrade of all building and pavement locations with six passes of a loaded tandem axle dump truck or 15 ton, pneumatic-tired or smooth drum roller. Operate the roller or truck in a systematic manner to ensure the number of passes over all areas, and at speeds between 2.5 to 3.5 miles per hour. Subgrade materials that exhibit excessive deflection and/or rutting during proof rolling need to be scarified, aerated, and re-compacted to specified density at plus or minus 2 percent of optimum moisture content prior to being considered for remedial action by the Contracting Officer. When proof rolling under buildings, the building subgrade is considered to extend 5 feet beyond the building lines, and make one-half of the passes with the roller in a direction perpendicular to the other passes.

3.3.4 Stockpiling Operations

Place and grade stockpiles of satisfactory materials as specified. Keep stockpiles in a neat and well drained condition, giving due consideration to drainage at all times. Clear, grub, and seal by rubber-tired equipment, the ground surface at stockpile locations; separately stockpile excavated satisfactory and unsatisfactory materials. Protect stockpiles of satisfactory materials from contamination which may destroy the quality and fitness of the stockpiled material. Do not create stockpiles that could obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, remove

and replace such material with satisfactory material from approved sources.

3.4 EXCAVATION

Excavate to contours, elevation, and dimensions indicated. Excavate soil disturbed or weakened by Contractor's operations, and soils softened or made unstable for subsequent construction due to exposure to weather. Use material removed from excavations meeting the specified requirements in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes to minimize surplus material and to minimize additional material to brought on site. Do not excavate below indicated depths except to remove unstable material as determined by the Government and confirmed by the Contracting Officer. Remove and replace excavations below the grades shown with appropriate materials as directed by the Contracting Officer.

If at any time during excavation, including excavation from borrow areas, the Contractor encounters material that may be classified as rock or as hard/unyielding material, uncover such material, and notify the Contracting Officer. Do not proceed with the excavation of this material until the Contracting Officer has classified the materials as common excavation or rock excavation. Failure on the part of the Contractor to uncover such material, notify the Contracting Officer, and allow sufficient time for classification and delineation of the undisturbed surface of such material will cause the forfeiture of the Contractor's right of claim to any classification or volume of material to be paid for other than that allowed by the Contracting Officer for the areas of work in which such deposits occur.

3.4.1 Ditches, Gutters, and Channel Changes

Finish excavation of ditches, gutters, and channel changes by cutting accurately to the cross sections, grades, and elevations shown. Do not excavate below grades shown. Backfill excessive excavation as directed by the Contracting Officer, with satisfactory, compacted, material or with suitable stone or cobble to grades shown. Dispose excavated material as shown or as directed. Do not allow material to be deposited within 4 feet from edge of a ditch. Maintain excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

3.4.2 Trench Excavation Requirements

Excavate the trench as recommended by the manufacturer of the pipe to be installed. Slope trench walls below the top of the pipe, or make vertical, and of such width as recommended by the manufacturer. Provide vertical trench walls where no manufacturer installation instructions are available. Do not exceed the trench width of 24 inches below the top pipe plus pipe outside diameter (O.D.) for pipes of less than 24 inches inside diameter, and do not exceed 36 inches plus pipe outside diameter for pipe sizes larger than 24 inches inside diameter. Where recommended trench widths are exceeded, provide redesign, stronger pipe, or special installation procedures. The Contractor is responsible for the cost of redesign, stronger pipe, or special installation procedures without any additional cost to the Government.

3.4.2.1 Bottom Preparation

Grade the bottoms of trenches accurately to provide uniform bearing and

support for the bottom quadrant of each section of the pipe. Excavate bell holes to the necessary size at each joint or coupling to eliminate point bearing. Remove stones of 3 inch or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, to avoid point bearing.

3.4.2.2 Removal of Unyielding Material

Where overdepth is not indicated and unyielding material is encountered in the bottom of the trench, notify the Contracting Officer. Following approval, remove such material 6 inches below the required grade and replaced with suitable materials as provided in paragraph FILLING AND COMPACTION.

3.4.2.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, remove such material to the depth directed and replace it to the proper grade with suitable material as provided in paragraph FILLING AND COMPACTION. When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the Contractor is responsible for excavating the resulting material and replacing it without additional cost to the Government.

3.4.2.4 Excavation for Appurtenances

Provide excavation for manholes, catch-basins, inlets, or similar structures sufficient to leave at least 12 inches clear between the outer structure surfaces and the face of the excavation or support members.

3.4.2.5 Gas Distribution

Excavate trenches to a depth that will provide a minimum 18 inches of cover in rock excavation and a minimum 24 inches of cover in other excavation.

3.4.2.6 Water Lines

Excavate trenches to a depth that provides a minimum cover of 5.5 feet from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe. For fire protection yard mains or piping, an additional 6 inches of cover is required.

3.4.3 Underground Utilities

Perform work adjacent to utilities in accordance with procedures outlined by utility owner. Excavation made with power-driven equipment is not permitted within 2 feet of known utility or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work affected by the contract excavation until approval for backfill is granted by the Contracting Officer. Report damage to utility lines or subsurface construction immediately to the Contracting Officer.

3.4.4 Structural Excavation

Following general excavation and rough grading activities, excavate the entire building footprint area and at least 3 feet beyond, to 3 feet below the bottom of footings and floor slabs. Scarify the exposed surface to a depth of 6 to 8 inches, moisture-condition, and compact to at least 95 percent of laboratory maximum density. Do not excavate to final grade until just before concrete is to be placed. Roughen level surfaces. Cut sloped surfaces as indicated into rough steps or benches to provide a satisfactory bond for compacting materials. For new pavement areas including exterior concrete pads, over-excavate to a minimum of 12 inches below bottom of new pavement/pad base course, scarify, moisture-condition, and compact to at least 95 percent.

Make excavations to the lines, grades, and elevations shown, or as directed. Provide trenches and foundation pits of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Clean rock or other hard foundation material of loose debris and cut to a firm, level, stepped, or serrated surface. Remove loose disintegrated rock and thin strata.

Concrete placement is not allowed until footing subgrades have been inspected and approved by the Contracting Officer.

3.5 SUBGRADE PREPARATION

3.5.1 General Requirements

Shape subgrade to line, grade, and cross section as indicated. Remove unsatisfactory and unstable material in surfaces to receive fill or in excavated areas, as determined by proof rolling, and replaced with structural fill. Do not place material on surfaces that are muddy, frozen, contain frost, or otherwise containing unstable material. Scarify the surface to a depth of 6 to 8 inches prior to placing fill. Step or bench sloped surfaces steeper than 1 vertical to 4 horizontal prior to scarifying. Place 4 inches of loose fill and blend with scarified material. When subgrade is part fill and part excavation or natural ground, scarify to a depth of 8 inches.

3.5.2 Subgrade for Structures, Spread Footings, and Concrete Slabs

Do not excavate below depth shown for structures, spread footings, and concrete slabs. If over excavation occurs, notify the Contracting Officer and remove, replace, and compact as directed. compact disturbed material to 95 percent of ASTM D1557. After final rolling, the surface of the subgrade for buildings and pavements must not show deviations greater than 0.05 foot when tested with a 12-foot straightedge applied both parallel and at right angles to the centerline of the area.

3.5.3 Subgrade for Pavements

Compact top 12 inches of subgrade for pavements to at least 95 percent of ASTM D1557. After final rolling, the surface of the subgrade for buildings and pavements must not show deviations greater than 0.05 foot when tested with a 12-foot straightedge applied both parallel and at right angles to the centerline of the area.

3.5.4 Subgrade for Shoulders

Compact the upper 12 inches of subgrade for shoulders to at least 95 percent of ASTM D1557 for the full depth of the shoulder.

3.6 FILLING AND COMPACTION

Prepare ground surface on which backfill is to be placed and provide compaction requirements for backfill materials in conformance with the applicable portions of paragraphs for SUBGRADE PREPARATION. Do not place material on surfaces that are muddy, frozen, or contain frost. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Moisten material as necessary to plus or minus 2 percent of optimum moisture. Fill and backfill to contours, elevations, and dimensions indicated. Compact and test each lift before placing overlaying lift.

3.6.1 Trench Backfill

Backfill trenches to the grade shown. Backfill the trench to 2 feet above the top of pipe prior to performing the required pressure tests. Leave the joints and couplings uncovered during the pressure test.

3.6.1.1 Replacement of Unyielding Material

Replace unyielding material removed from the bottom of the trench with satisfactory material or initial backfill material.

3.6.1.2 Replacement of Unstable Material

Replace unstable material removed from the bottom of the trench or excavation with satisfactory material placed in layers not exceeding 6 inches loose thickness.

3.6.1.3 Bedding and Initial Backfill

Provide bedding of the type and thickness shown. Place initial backfill material and compact it with approved tampers to a height of at least one foot above the utility pipe or conduit. Bring up the backfill evenly on both sides of the pipe for the full length of the pipe. Take care to ensure thorough compaction of the fill under the haunches of the pipe. Except where shown or when specified otherwise in the individual piping section, provide bedding for buried piping in accordance with PART 2 paragraph UTILITY BEDDING MATERIAL. Compact backfill to top of pipe to 85 percent of ASTM D1557. Provide plastic piping with bedding to spring line of pipe.

3.6.1.4 Final Backfill

Do not begin backfill until construction below finish grade has been approved, underground utilities systems have been inspected, tested and approved, forms removed, and the excavation cleaned of trash and debris. Bring backfill to indicated finish grade. Where pipe is coated or wrapped for protection against corrosion, the backfill material up to an elevation 2 feet above sewer lines and one foot above other utility lines need to be free from stones larger than one inch in any dimension. Heavy equipment for spreading and compacting backfill are not to be operated closer to foundation or retaining walls than a distance equal to the height of

backfill above the top of footing; compact remaining area in layers not more than 4 inches in compacted thickness with power-driven hand tampers suitable for the material being compacted. Place backfill carefully around pipes or tanks to avoid damage to coatings, wrappings, or tanks. Do not place backfill against foundation walls prior to 7 days after completion of the walls. As far as practicable, bring backfill up evenly on each side of the wall and sloped to drain away from the wall.

Fill the remainder of the trench, except for special materials for buildings and pavements with satisfactory material. Place backfill material and compact as follows:

3.6.1.4.1 Buildings and Pavements

Place backfill up to the required elevation as specified. Do not permit water flooding or jetting methods of compaction. Compact as specified for Structural Fill.

3.6.1.4.2 Turfed or Seeded Areas and Miscellaneous Areas

Deposit backfill in layers of a maximum of 12 inches loose thickness, and compact it to 85 percent maximum density for cohesive soils and 90 percent maximum density for cohesionless soils. Do not permit compaction by water flooding or jetting. Apply this requirement to all other areas not specifically designated above.

3.6.1.5 Heat Distribution System

Free initial backfill material of stones larger than 1/4 inch in any dimension.

3.6.1.6 Electrical Distribution System

Provide a minimum cover of 24 inches from the finished grade to direct burial cable and conduit or duct line, unless otherwise indicated.

3.6.1.7 Displacement of Features

After other required tests have been performed and the trench backfill compacted to the finished grade surface, inspect the pipe to determine whether unexpected or damaging displacement has occurred. Conduct walk-through inspection of pipe sizes larger than 48 inches. Inspect pipes smaller than 48 inches using remote methods using closed circuit television, sonar, or hybrid that can provide a 360-degree inspection of the pipe. Prepare and submit a pipe inspection report consisting of digital video or photos. If, in the judgment of the Contracting Officer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, replace or repair the defects as directed at no additional cost to the Government.

3.6.1.8 Buried Tape And Detection Wire

3.6.1.8.1 Buried Warning and Identification Tape

Provide buried utility lines with utility identification tape. Bury tape 12 inches below finished grade; under pavements and slabs, bury tape 6 inches below top of subgrade.

3.6.1.8.2 Buried Detection Wire

Bury detection wire directly above non-metallic piping at a distance not to exceed 12 inches above the top of pipe. Extend the wire continuously and unbroken, from manhole to manhole. Terminate the ends of the wire inside the manholes at each end of the pipe, with a minimum of 3 feet of wire, coiled, remaining accessible in each manhole. Furnish insulated wire over its entire length. Install wires at manholes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal. For force mains, terminate the wire in the valve pit at the pump station end of the pipe.

3.6.2 Structural Fill Placement

Place fill and backfill beneath and adjacent to structures in successive horizontal layers of loose material not more than 8 inches in depth, or in loose layers not more than 4 inches in depth when using hand-operated compaction equipment. Do not place over wet or frozen materials. Compact to at least 95 percent of laboratory maximum density. Perform compaction in such a manner as to prevent wedging action or eccentric loading upon or other damage to the structure. Moisture condition fill and backfill material to within range of plus 2 or minus 2 percent of optimum moisture content at the time of compaction.

3.6.3 Backfill for Appurtenances

After the manhole, catchbasin, inlet, or similar structure has been constructed and the concrete has been allowed to cure for 7 days, place backfill in such a manner that the structure is not be damaged by the shock of falling earth. Deposit the backfill material, compact it as specified for final backfill, and bring up the backfill evenly on all sides of the structure to prevent eccentric loading and excessive stress.

3.6.4 Porous Fill Placement

Provide under floor and area-way slabs on a compacted subgrade. Place in a single lift and compact with a minimum of two passes of a hand-operated plate-type vibratory compactor.

3.6.5 Flowable Fill

If necessary, place fill in a manner to completely fill voids in the location indicated. Do not place when atmospheric temperatures are expected to be below 33 degrees F at any time during the 3 day period following placement.

3.6.6 Compaction

3.6.6.1 General Site

Compact underneath areas designated for vegetation and areas outside the 5 foot line of the paved area or structure to 90 percent of ASTM D1557.

3.6.6.2 Adjacent Areas

Compact areas within 5 feet of structures to 95 percent of ASTM D1557.

3.7 RIP-RAP CONSTRUCTION

Construct rip-rap on geotextile fabric in accordance with State of Colorado DOT Specifications in the areas indicated. Trim and dress indicated areas to conform to cross sections, lines and grades shown within a tolerance of 0.1 foot.

3.7.1 Geotextile Placement

Spread geotextile fabric on prepared subgrade as indicated and per manufacturer specifications.required.

3.7.2 Stone Placement

Place rock for rip-rap on geotextile fabric to produce a well graded mass with the minimum practicable percentage of voids in conformance with lines and grades indicated. Distribute larger rock fragments, with dimensions extending the full depth of the rip-rap throughout the entire mass and eliminate "pockets" of small rock fragments. Rearrange individual pieces by mechanical equipment or by hand as necessary to obtain the distribution of fragment sizes specified above.

3.8 FINISHING/FINISH OPERATIONS

During construction, keep embankments and excavations shaped and drained. Maintain ditches and drains along subgrade to drain effectively at all times. Do not disturb the finished subgrade by traffic or other operation. Protect and maintain the finished subgrade in a satisfactory condition until ballast, subbase, base, or pavement is placed. Do not permit the storage or stockpiling of materials on finished subgrade. Do not lay subbase, base course, ballast, or pavement until the subgrade has been checked and approved, and in no case place subbase, base, surfacing, pavement, or ballast on a muddy, spongy, frozen or otherwise unstable subgrade.

Finish the surface of excavations, embankments, and subgrades to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. Provide the degree of finish for graded areas within 0.1 foot of the grades and elevations indicated except as indicated for subgrades specified in paragraph SUBGRADE PREPARATION. Finish gutters and ditches in a manner that will result in effective drainage. Finish the surface of areas to be turfed to a smoothness suitable for the application of turfing materials. Repair graded, topsoiled, or backfilled areas prior to acceptance of the work, and re-established grades to the required elevations and slopes.

3.8.1 Capillary Water Barrier

Place a capillary water barrier under concrete floor and area-way slabs grade directly on the subgrade and compact with a minimum of two passes of a hand-operated plate-type vibratory compactor.

3.8.2 Grading Around Structures

Construct areas within 5 feet outside of each building and structure line true-to-grade, shape to drain, and maintain free of trash and debris until final inspection has been completed and the work has been accepted.

3.8.3 Shoulder Construction

Construct shoulders of structural fill. Submit advanced notice on shoulder construction for rigid pavements. Construct shoulders immediately after adjacent paving is complete. In the case of rigid pavements, do not construct shoulders until permission of the Contracting Officer has been obtained. Compact the entire shoulder area to at least the percentage of maximum density as specified in paragraph SUBGRADE PREPARATION above, for specific ranges of depth below the surface of the shoulder. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Finish shoulder construction in proper sequence in such a manner that adjacent ditches will be drained effectively and that no damage of any kind is done to the adjacent completed pavement. Align the completed shoulders true to grade and shaped to drain in conformity with the cross section shown.

3.8.4 Grading

Finish grades as indicated within one-tenth of one foot. Grade areas to drain water away from structures. Maintain areas free of trash and debris. For existing grades that will remain but which were disturbed by Contractor's operations, grade as directed.

3.8.5 Topsoil and Seed

On areas to receive topsoil, prepare the compacted subgrade soil to a 2 inches depth for bonding of topsoil with subsoil. Spread topsoil evenly to a thickness of 4 inches and grade to the elevations and slopes shown. Do not spread topsoil when frozen or excessively wet or dry. Keep topsoil separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 2 inches in diameter, and other materials that would interfere with planting and maintenance operations. Remove from the site any surplus of topsoil from excavations and gradings. Obtain material required for topsoil in excess of that produced by excavation within the grading limits from offsite areas.

3.9 DISPOSITION OF SURPLUS MATERIAL

Remove from Government property all surplus or other soil material not required or not suitable for filling or backfilling, along with brush, refuse, stumps, roots, and timber. Properly disposed of in accordance with all applicable laws and regulations. Prepare plan for Disposition of Surplus Materials to include permissions document to dispose of nonsalable products.

3.10 TESTING

Submit Material Test Reports within 24 hours of tests being completed. Perform testing by a Corps validated commercial testing laboratory or the Contractor's validated testing facility. Submit qualifications of the Corps validated commercial testing laboratory or the Contractor's validated testing facilities. If the Contractor elects to establish testing facilities, do not permit work requiring testing until the Contractor's facilities have been inspected, Corps validated and approved by the Contracting Officer.

a. Determine field in-place density in accordance with ASTM D1556/D1556M ASTM D2167 or ASTM D6938.

b. Check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D6938; check the calibration of both the density and moisture gauges at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer. When test results indicate, as determined by the Contracting Officer, that compaction is not as specified, remove the material, replace and recompact to meet specification requirements.

c. Perform tests on recompacted areas to determine conformance with specification requirements. Appoint a registered professional civil engineer to certify inspections and test results. State that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.

3.10.1 Fill and Backfill Material Gradation

One test per 500 cubic yards stockpiled or in-place source material. Determine gradation of fill and backfill material in accordance with ASTM C136/C136M or ASTM D1140.

3.10.2 In-Place Densities

a. One test per 2,500 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines.

b. One test per 500 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.

c. One test per 1,000 linear feet, or fraction thereof, of each lift of embankment or backfill for roads.

3.10.3 Moisture Contents

In the stockpile, excavation, or borrow areas, perform a minimum of two tests per type of material or source of material being placed during stable weather conditions. During unstable weather, perform tests as dictated by local conditions and approved by the Contracting Officer.

3.10.4 Optimum Moisture and Laboratory Maximum Density

Perform tests for each type material or source of material including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per 500 cubic yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

Tolerance Tests for Subgrades

Perform continuous checks on the degree of finish specified in paragraph SUBGRADE PREPARATION during construction of the subgrades.

-- End of Section --

Attachment to 31 00 00

Geotechnical Engineering Report - For Information Only

The following report is being provided for information only to prospective bidders. Note that the Government does not warrant consistency or accuracy of the report in relation to the specifications and drawings that serve as the basis for bidding the work. Use of the report will not limit compliance with the requirements in this contract contained in the specifications and design drawings.

US Army Corps of Engineers ®
Omaha District

Geotechnical Engineering Report

Power Independence Mission Control Station
Buckley Space Force Base, Colorado

U.S. Army Corps of Engineers, Omaha District
Geotechnical Engineering & Sciences Branch
January 2025

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1.0 Introduction

This report presents the results of a subsurface investigation and geotechnical engineering analysis for the proposed Power Independence Mission Control Station project at Buckley Space Force Base (SFB) in Aurora, Colorado. The purpose of this report is to provide geotechnical recommendations relative to site preparation, earthwork, foundations, and pavements for the proposed project.

2.0 Site and Project Description

Site and Project Description	
Project Location	The project site is located within the PL-1 Restricted Area at the northwest side of Buckley SFB in Aurora, Colorado. Latitude: 39.71598°, Longitude: -104.77870° (approximate center of site).
Project Description	This project includes the construction of a new Mission Control Station (MCS) power plant building and associated roadway pavements, sidewalks, utilities, and fuel farm storage system. The MCS building and fuel storage structures will feature slabs-on-grade and be supported on a shallow foundation system. The fuel storage structures will be supported on shallow spread footings and/or mat foundations. Maximum expected column loads for the power plant structure are 200 kips axial and 150 kips uplift. Generators planned for the structure will be 70 kips each. Installation of underground utility lines will require the use of trenchless construction methods at a few locations where lines will cross beneath existing roadways.
Site Description	The MCS building site is currently occupied by three buildings that will be completely removed to facilitate construction of the power plant: Buildings 417, 423, and 424. The existing buildings are surrounded by asphalt paving and underground utility lines associated with their function. The fuel storage farm site is currently occupied by a storage yard containing a small building, concrete paving, and perimeter fencing.
Site Topography and Grading	The site is relatively flat with less than 2 feet of grade change across the proposed structure areas. Minimal grading is expected. The proposed FFE of the new building is expected to be within 1 foot of existing grade.

3.0 Subsurface Investigation

3.1 Field Investigation

The field investigation for this project was completed in August 2024. The investigation included the advancement of seven soil borings to depths of approximately 20 to 98.4 feet and four cone penetration test (CPT) soundings to depths of approximately 41.3 to 66 feet below the ground surface.

The boring and CPT locations were selected by the geotechnical engineer and located at the site by a USACE Omaha District drill crew. The following table presents the approximate coordinates and ground surface elevations at each location.

Boring Information

Boring	Latitude	Longitude	Northing [1]	Easting [1]	Depth [2]	Elevation [3]
BU24-01	39.71598°	-104.77870°	1686480.607	3202912.867	71.2 ft	5,532.0 ft
BU24-02	39.71586°	-104.77825°	1686437.902	3203039.804	98.4 ft	5,533.5 ft
BU24-03	39.71569°	-104.77783°	1686376.918	3203158.446	78.6 ft	5,534.0 ft
BU24-04	39.71570°	-104.78007°	1686375.559	3202528.281	20.0 ft	5,524.5 ft
BU24-05	39.71521°	-104.78025°	1686196.673	3202479.059	20.0 ft	5,525.0 ft
BU24-06	39.71539°	-104.78119°	1686260.145	3202214.107	20.0 ft	5,520.0 ft
BU24-07	39.71496°	-104.78118°	1686103.538	3202218.159	20.0 ft	5,524.0 ft
BUCPT-01	39.71569°	-104.77867°	1686375.655	3202921.521	52.7 ft	5,531.0 ft
BUCPT-02	39.71584°	-104.77829°	1686430.136	3203029.709	54.2 ft	5,533.5 ft
BUCPT-03	39.71592°	-104.77791°	1686461.316	3203134.960	66.0 ft	5,534.0 ft
BUCPT-04	39.71557°	-104.78016°	1686327.797	3202504.578	41.3 ft	5,525.0 ft

1. United States State Plane Coordinates, US Survey Feet, Zone 0502, Colorado Central.
2. Depth drilled below top of ground surface or pavement.
3. Top of boring elevation obtained from survey information. Values have been rounded to nearest tenth foot. Vertical datum NAVD88.

The subsurface investigation was performed by a USACE Omaha District drill crew. The borings were advanced with a Gus Pech 1100c drilling rig utilizing 4.25-inch inside diameter (I.D.) hollow stem augers and a 4-inch center bit. Samples were taken at depth intervals of approximately 2.5 feet in the upper 10 feet of each boring, then approximately every 5 feet for the remainder of the boring. Representative samples were obtained using disturbed (split-barrel) and undisturbed (thin-walled tube) sampling procedures. In the disturbed sampling procedure, a standard 2-inch O.D. split-barrel sampling spoon was driven into the ground with an automated 140-pound hammer falling a distance of 30 inches. Standard penetration tests (SPTs) were performed during sampling

by recording the number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration. The standard penetration resistance values are indicated on the boring logs at the depths of occurrence. In the undisturbed sampling procedure, a thin-walled, 3-inch O.D., seamless steel tube with a sharp cutting edge was pushed hydraulically into the ground to obtain relatively undisturbed samples of cohesive or moderately cohesive soils. The samples were sealed and transported to the laboratory for testing and classification.

Rock core samples were obtained from three borings using a coring bit and barrel. Rock coring commenced in the boring upon auger refusal. Rock Quality Designation (RQD) values of the core samples were calculated in the field. The RQD provides a quantitative estimate of rock mass quality from a rock core sample. Core samples were preserved, sealed, and thoroughly secured to ensure no damage occurred during transportation. Rock coring activities generally followed ASTM D2113-14.

The CPT soundings were advanced with a 20-ton truck-mounted cone penetrometer platform. The CPT tool consisted of a 15-ton cone having a 60° apex angle at the conical point, 15 cm^2 base area, and a filter in the U2 location. CPT data was collected as the penetrometer tip was advanced through the soil at a constant rate of 20 mm/s. The force on the cone required to penetrate the soil was measured by electrical methods and recorded at a minimum of every 50 mm of penetration. Stress was calculated by dividing the measured force (total cone force) by the cone base area to obtain cone resistance (qc). Porewater pressure was induced during the advancement of the penetrometer tip using an electronic pressure transducer and measured at the same rate as the force. The CPT was conducted in accordance with ASTM 5778-07, "Standard Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils."

3.2 Laboratory Testing

Soil samples obtained from the site were transported to Terracon Consultants, Inc. in Omaha, Nebraska for laboratory testing. The following laboratory tests were performed on selected samples:

- Visual description and identification of soils (ASTM D2488)
- Water content (ASTM D2216)
- Density determination (ASTM D7263)
- Unconfined Compressive Strength (ASTM D2166/ASTM D7012)
- Atterberg limits (ASTM D4318)
- Grain size sieve analysis (ASTM D6913)
- Grain size hydrometer analysis (ASTM D7928)
- One-dimensional swell test (ASTM D4546)
- Moisture-density relationship (ASTM D1557)
- Chemistry testing (see description below)

The soil descriptions presented in this report are in general accordance with the Unified Soil Classification System (USCS) and are based on the results of laboratory testing. The group symbol for the USCS is shown on the boring log sheets in Appendix B. Laboratory test results are located in Appendix C.

Chemistry testing included soil resistivity, pH, and electrical conductivity tests performed on selected samples. The chemistry testing results are located in Appendix C and include a description of sulfate risk and corrosion potential associated with these soils.

The noted procedural standards are for reference to methodology in general. Variations to methods can be applied as a result of professional judgment.

4.0 Subsurface Conditions

4.1 General Geology

The geology of Buckley SFB consists of unconsolidated eolian and alluvial deposits overlying bedrock (Denver Formation). These deposits range in thickness from 2 to 29 feet and consist of silty clay with occasional discontinuous layers of silty sand at the base just above the Denver Formation.

The Denver Formation underlying Buckley SFB is composed of fractured and unfractured, hard, brown claystones and siltstones with occasional discontinuous lenticular beds of brown silty sandstones and dense, fine- to coarse-grained sandstones ranging in thickness from a few inches to several feet. The interbedded sandstone varies in thickness both laterally and vertically: there is no evident increase or decrease in thickness in any direction or change of depth. In general, however, sandstones encountered 50 feet below ground surface (bgs) are coarser grained. The sandy and silty sand underbeds encountered above 50 feet bgs do not appear to be laterally continuous across the entire base, but a reasonably short distance correlation can be made between several of the interbeds.

Groundwater at Buckley SFB exists within the eolian and alluvial deposits, as well as in the Denver Formation. It is primarily in the discontinuous layers of coarse-grained materials (sand and sandstones) within the fine-grained materials (clay, silt, claystones, and siltstones). Groundwater in the Denver Formation may also exist in fractured sections of siltstones and claystones. The Laramie-Fox Hills, Arapahoe, and Denver aquifers are three principal bedrock aquifers at Buckley AFB. Regional groundwater flow is generally to the northwest, following the trend of stream drainages toward the South Platte River north of Denver.

4.2 Site Geology

The MCS site is consistent with the regional geology and is characterized predominantly by sandy lean clay soils overlying poorly graded sand with variable amounts of clay overlying bedrock. Lenses of interbedded sand exist within the sandy lean clay layers, increasing in frequency with

depth. The clay soils encountered were typically stiff to very stiff and extended to depths of approximately 30 to 40 feet below the ground surface before encountering the poorly graded sand. Lenses of soft to medium stiff soil were encountered to depths of approximately 6 feet below the ground surface. The poorly graded sand was typically medium dense.

Top of bedrock was encountered at depths of approximately 54 to 59 feet and consisted of weathered shale overlying siltstone/sandstone conglomerate.

Field and CPT logs with more detailed soil and bedrock descriptions can be found in Appendix B.

4.3 Groundwater

The borings were observed during and after drilling for the presence and level of groundwater. The following table notes the groundwater depths in each boring.

Groundwater Depths [1]				
Boring	**Groundwater during**	**Groundwater 24 hours after drilling**	**Cave-in immediately after drilling**	**Cave-in 24 hours after drilling**
BU24-01	Not encountered	21.1 ft	Not encountered	Not encountered
BU24-02	Not encountered	39.9 ft	Not encountered	57.0 ft
BU24-03	Not encountered	32.0 ft	Not encountered	Not encountered
BU24-04	Not encountered	Not measured	17.5 ft	Not measured
BU24-05	Not encountered	Not measured	17.5 ft	Not measured
BU24-06	Not encountered	Not measured	16.1 ft	Not measured
BU24-07	Not encountered	Not measured	17.6 ft	Not measured

1. Depth below top of ground surface.

A relatively long period of time is necessary for a groundwater level to develop and stabilize in a boring. Longer term monitoring in cased holes or piezometers would be required for a more accurate evaluation of the groundwater conditions.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff, and other factors not evident at the time the borings were performed. Groundwater levels during construction or at other times in the life of the structures may be higher or lower than the levels indicated in this report.

5.0 Seismic Evaluation

Buckley SFB has a 0.2-second spectral response acceleration (Ss) of 0.193 g and a 1.0-second spectral response acceleration (S1) of 0.055 g in reference to the American Society of Civil Engineers *Minimum Design Loads for Buildings and other Structures (ASCE 7-16)*, the Department of Defense (DoD) *Unified Facilities Criteria (UFC) Seismic Design for Buildings (UFC 3-301-01)* dated October 1, 2019, and the International Building Code (IBC) 2018. These accelerations are interpolated from 1:5,000,000 scale maps prepared by the U.S. Geological Survey (USGS), the Building Seismic Safety Council (BSSC), and the ASCE 7 Seismic Subcommittee for 0.2-second spectral response acceleration (5% critical damping), Site Class D, and 1.0-second spectral response acceleration (5% critical damping), Site Class D, respectively. These accelerations were confirmed by using the USGS Seismic Design Web Services web-based tool available at https://hazards.atcouncil.org.

For all structures located within regions of the maps having Ss values greater than 0.15 g, or S1 values greater than 0.04 g, the spectral response accelerations taken from these maps must be adjusted for site class effects using coefficients provided in the aforementioned guidance. Chapter 20 of ASCE 7-16, Site Classification provides six site classes, Class A through Class F, which are defined on various geotechnical parameters (shear wave velocity, standard penetration resistance, or undrained shear strength). For this investigation, site classification is based on shear wave velocity from CPT soundings, standard penetration resistance (i.e., SPT blow counts) in the overburden soils, and estimated shear wave velocities in bedrock based on core samples to 100 feet. For design purposes, the referenced site condition for this project is taken as Site Class C, based on the shear wave and standard penetration resistance (ASTM D1586) data collected during this investigation.

The adjusted maximum considered earthquake spectral response acceleration parameters (USGS values) using the Site Class C response coefficients are:

- The short-period spectral acceleration ($S_{MS} = F_a S_S$) is (1.300 x 0.193) = 0.251
- The 1-second period spectral acceleration ($S_{M1} = F_v S_1$) is (1.500 x 0.055) = 0.083

Summary of Seismic Design Parameters

Site Location	Site Class	PGA (g)	S_S (g)	S_1 (g)	F_{PGA}	F_a	F_v	PGA_M	S_{MS} (g)	S_{M1} (g)
Buckley SFB	C	0.104	0.193	0.055	1.296	1.300	1.500	0.134	0.251	0.083

6.0 Geotechnical Overview

The following summary highlights key geotechnical issues that form the basis of the geotechnical recommendations provided in this report.

- **Medium Stiff Soils:** Medium stiff, sandy lean clay soils were encountered at and below the anticipated footing and floor slab bearing levels. These soils present a risk of larger than tolerable settlement and reduced bearing capacity in their current condition. On-site soils shall be overexcavated, reworked, and recompacted to a depth of 3 feet below footings and floor slabs. If on-site soils do not meet the requirements for structural fill (see 7.4 **Fill Material and Compaction Requirements**), importing of structural fill is required. Additional information is provided in **7.2 Overexcavation of Bearing Soils**.

- **Expansive Soils:** Moderate-plasticity clay soils were encountered in the borings. These soils present a moderate risk of shrinking and/or swelling with changes in moisture content. Structures supported on these soils could experience unacceptable levels of movement if the soils should become wetted during the life of the structure. Based on swell tests performed on representative soils samples, the foundations appear to provide enough load to keep expansion of the soil within a tolerable limit. However, the floor slab is unlikely to provide enough load to prevent heave of these soils. Limited removal and replacement with low-plasticity structural fill as prescribed in **7.2 Overexcavation of Bearing Soils** and sloping grades away from structures will reduce the likelihood and soil expansion due to wetting.

- **Existing Fill:** Existing fill will likely be encountered below pavements, above and surrounding existing utility lines, and in the vicinity of existing structures. Existing fill and possible fill are noted on the boring logs in Appendix B. Existing fill presents a risk of larger than tolerable and unpredictable settlement due to potential variations in site preparation, composition, and compaction of the fill. If encountered, removal and replacement or recompaction of existing fill beneath structures would reduce the risk posed by the fill. Existing fill will likely be removed incidentally during the overexcavation procedures outlined in this report. Existing fill can remain below pavements with low risk.

- **Temporary Support of Excavation:** Excavations required for the MCS building will extend below adjacent building foundations, utilities, and pavements. Care should be taken to prevent undermining of these features associated with other site facilities. Due to the proximity of the MCS building to other structures, temporary support of excavation will likely be required to facilitate the overexcavation procedures prescribed in this report. Additional information is provided in **7.3 Temporary Support of Excavation**.

- **Foundations:** The MCS Building and other site structures can be supported on a shallow foundation system bearing on structural fill placed in accordance with the recommendations in

this report. A minimum of 3 feet of structural fill shall be provided below footings by overexcavating existing soils and replacing with imported material. Recommendations for design and installation of a spread footing foundation system are presented in section **8.0 Foundations**.

Design and construction recommendations are presented in the following sections.

7.0 Earthwork

7.1 Site Preparation

Stripping of all vegetation, organic topsoil, and any other materials unsuitable for re-use as structural fill shall be performed within the building and pavement areas. A stripping depth of about 6 to 12 inches is expected to be adequate in most areas. Extend site stripping and subgrade preparation procedures at least 5 feet beyond the structure perimeters and 2 feet beyond pavements, where feasible.

Existing structures and utility lines are present at the site and extend throughout building and pavement areas. Reroute existing utility lines outside of the proposed construction areas and completely remove abandoned utility lines and subsurface features of existing structures to be demolished. Poorly compacted backfill is commonly found in utility line trenches and adjacent to existing subsurface structures. Rework and recompact backfill associated with these features in accordance with section **7.4 Fill Material and Compaction Requirements**.

7.2 Overexcavation of Medium Stiff Soils

Excavate the on-site soils to a depth of at least 3 feet below the bottom of the building footings structural pads, and floor slabs. The footing excavations should extend laterally to a distance of at least 3 feet beyond footing edges. Excavation slopes shall adhere to requirements outlined in EM 385-1-1. After excavation of the existing soils, place and compact structural fill within the excavation in accordance with **7.4 Fill Material and Compaction Requirements**. Refer to the following overexcavation detail.

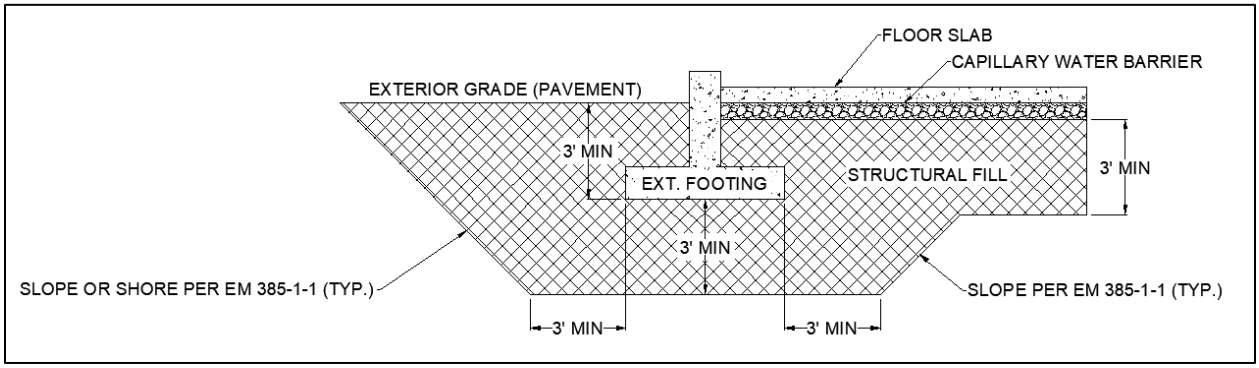


Figure 7.2 Overexcavation Detail

7.3 Temporary Support of Excavation

Excavations for the MCS Building shall not extend below footings of adjacent structures within a lateral distance of 10 feet from the outer edge of the footings. If such excavations are required, temporary support of excavation or underpinning of existing structures will be necessary. The design of any shoring or temporary support of excavation is typically the responsibility of the contractor.

All excavations must comply with applicable local, state, and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards, and USACE EM 385-1-1 Safety and Health Requirements Manual. All excavations should comply with the requirements of OSHA 29 CFR, Part 1926, Subpart P, "Excavations and Trenches".

All excavations are expected to encounter predominately sandy lean clay soils. These soils will classify as Type A or B in accordance with 29 CFR, Part 1926, Subpart P. Maximum allowable slopes for excavations less than 20 feet are ¾H:1V for Type A soils and 1H:1V for Type B soils.

If vertical excavation cuts are required, temporary excavation support is required to resist a uniform lateral earth pressure of at least 40 H in psf, where H is the maximum excavation depth below grade in feet. Shoring shall also be designed to resist hydrostatic pressures for excavations extending below the water table. This may be accounted for by adding an equivalent fluid pressure of 40 pcf for the portion of the retention system that extends below the water table. These pressures do not account for surcharge loads due to construction equipment or stockpiled soil, which shall be considered in the shoring design. However, excavations for this project are not anticipated to extend below groundwater.

7.4 Fill Material and Compaction Requirements

Fill Material and Compaction Requirements [1, 2, 3]

Material	Location	Compaction/Moisture Content
Structural Fill: Low-plasticity, cohesive soil with liquid limit (LL) ≤ 50 and plasticity index (PI) ≥ 10 and ≤ 25 or sands with fines content greater than 30% by weight. Other soil classifications may be acceptable upon approval by the geotechnical engineer. USCS Classification: CL, SC, SM	Below footings, floor slabs, and structural pads.	• Compact each lift to 95% of the modified laboratory compaction maximum dry density (ASTM D1557). • Moisture content shall be within the range of -2 and +2% of the optimum moisture content value as determined by ASTM D1557.

Fill Material and Compaction Requirements [1, 2, 3]		
Material	**Location**	**Compaction/Moisture Content**
Utility Bedding and Backfill: Imported material classifying as gravel or sand with no more than 5% by weight may pass the No. 200 sieve. USCS Classification: GP, GW, SP, SW	In utility trenches and other locations as indicated in specification Section 31 00 00 Earthwork.	• Compact each lift to 95% of the modified laboratory compaction maximum dry density (ASTM D1557). • Moisture content shall be within the range of -2 and +2% of the optimum moisture content value as determined by ASTM D1557.
Pavement Subgrade: On-site soils can remain in place as pavement subgrade. If grade raise below pavements is required, Structural Fill shall be used. USCS Classification: CL, SC, SM	Directly below pavement base course.	• Recompact top 12 inches to 95% of the modified laboratory compaction maximum dry density (ASTM D1557). • Moisture content shall be within the range of -2 and +2% of the optimum moisture content value as determined by ASTM D1557.
Capillary Water Barrier: Poorly-graded crushed stone or gravel with 100% passing the 1½-inch sieve and less than 5% passing the No. 200 sieve. USCS Classification: GP	Directly below interior floor slabs	• Compact each lift to 95% of the modified laboratory compaction maximum dry density (ASTM D1557). • Moisture content shall be within the range of -2 and +2% of the optimum moisture content value as determined by ASTM D1557.
General Fill: On-site soils or imported cohesive satisfactory materials. USCS Classification: Varies. Must meet requirement for cohesive soils and satisfactory materials as described in 31 00 00 Earthwork.	Generally suitable for use in all locations not discussed in this table.	• Compact each lift to 90% of the modified laboratory compaction maximum dry density (ASTM D1557). • Moisture content shall be within the range of -2 and +2% of the optimum moisture content value as determined by ASTM D1557.

Fill Material and Compaction Requirements [1, 2, 3]		
Material	**Location**	**Compaction/Moisture Content**

1. Fill shall be placed in loose lifts not to exceed 8 inches.
2. Satisfactory fill material must consist of approved materials that are free of organic matter and/or debris.
3. Sorting of topsoil and on-site soils containing debris, organics, etc. will be necessary.

7.5 Construction Considerations

All trench excavations must be made with sufficient working space to permit construction, including backfill placement and compaction. Utility trenches are a common source of water infiltration and migration. If utility trenches are backfilled with relatively clean, granular material, cap the trenches with at least 18 inches of cohesive fill in non-pavement areas to reduce the infiltration and conveyance of surface water through the trench backfill. Additionally, install a trench plug that extends at least 5 feet out from the face of the building exterior. The plug material must consist of clay compacted at a water content at or above the soil's optimum water content. Place the clay plug to completely surround the utility line and compact in accordance with recommendations in this report.

The soils encountered in the borings demonstrate sensitivity to disturbance from construction activity and water seepage. Precipitation, poor site drainage, or ponding of surface water can cause an increase in moisture content and reduce the soil's strength, resulting in detrimental performance of the structure. Surface water must not be allowed to pond on the site and soak into the soil during construction. Construction staging must provide positive drainage of surface water and precipitation away from the structure. Promptly remove any water that collects over or adjacent to construction areas along with any softened or disturbed soils. Surface water control in the form of sloping surfaces, drainage ditches and trenches, and sump pits and pumps can be used to prevent ponding and associated delays due to precipitation and seepage.

After completion of grading, the subgrade moisture content must be maintained prior to construction. Avoid construction traffic over the completed subgrade. Remove subgrade material that becomes disturbed, saturated, frozen, or desiccated; or scarify, moisture condition, and recompact the material prior to construction of floor slabs and footings.

Slope final surrounding grades away from the building exterior for a minimum distance of 10 feet at a slope of not less than 5% for unpaved areas, and not less than 2% for paved areas. Gutters and downspouts that drain water a minimum of 10 feet beyond the footprint of the building are recommended. Avoid ponding water at or near the building at all times, with grading incorporating ditches, swales, culverts, and other means necessary to convey all surficial moisture away from the building.

8.0 Foundations

Support the building on a shallow spread footing foundation system. Design recommendations for shallow foundations are presented in the following table.

Shallow Foundation Design Parameters	
Net allowable soil bearing pressure [1]	2,500 psf
Minimum embedment [2]	36 inches
Bearing material	At least 3 feet of structural fill placed in accordance with section **7.5 Fill Material and Compaction Requirements**. Overexcavation and recompaction of on-site soils beneath footings is acceptable.
Ultimate coefficient of sliding friction	0.3
Coefficient of subgrade reaction (k) [3]	Square foundation on cohesive soils: $k = k_1 \left(\frac{1}{B}\right)$ Rectangular foundation on cohesive soils: $k = \frac{k_{BxB}\left(1 + 0.5\left(\frac{B}{L}\right)\right)}{1.5}$ Where k_1 = 75 pci for stiff clay k_{BxB} = k-value calculated for square foundation B = foundation width L = foundation length
Estimated total settlement [4]	< 1 inch
Estimated differential settlement [4]	2/3-inch over 40 feet

Shallow Foundation Design Parameters

1. The pressure in excess of the minimum surrounding overburden pressure at the footing base elevation.
2. Using a singular k value is an oversimplified approach for evaluation of concrete pad foundations. FEM-based analysis can provide a more accurate approach to k value estimation. The equation provided assumes minimal long-term consolidation, a relatively uniform subgrade, and that foundations will bear on stiff cohesive soils.
3. For frost protection and to reduce the effects of seasonal moisture variations in the subgrade soils for perimeter footings and footings in unheated areas.
4. The foundation settlement will depend upon the variations within the soil profile, structural loading conditions, embedment depth, thickness of compacted fill, and quality of the earthwork operations. The settlement estimates are based on these factors matching the information and recommendations presented in this report.

9.0 Below-Grade Structures

If below-grade structures are planned, design reinforced concrete walls with unbalanced backfill levels using design parameters shown in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction, and strength of the materials being restrained.

Below-Grade Wall Design Parameters [1]	
Unit Weight of Backfill	120 pcf
Internal Friction Angle of Backfill	28°
Earth Pressure Coefficients (Granular Soils)	Active (ka) = 0.42 At-Rest (ko) = 0.50 Passive (kp) = 2.40

1. Assumes soils adjacent to below-grade walls are predominately cohesive soils. Backfill placed against structures shall consist of Structural Fill soils listed in **7.4 Fill Material and Compaction Requirements.**

Loads bearing behind the wall will have significant influence on the lateral earth pressure. Structural analyses must indicate that walls can withstand the increased pressure from loading within the zone of active soil influence, if applicable. Apply earth pressures from loads at the top of the wall uniformly to the wall.

It is assumed that below-grade walls for this project will be subjected to hydrostatic pressure caused by the groundwater table. A drainage system is not required behind the wall if properly protected against surface water drainage and/or designed to withstand hydrostatic loading and resist buoyant uplift. Structures should be watertight with waterstops placed at all joints to reduce the potential for seepage through the wall joints.

10.0 Floor Slabs

Design recommendations for floor slabs have been summarized in the following table.

Floor Slab Design Parameters	
Floor slab support	Capillary water barrier underlain by at least 3 feet of structural fill. See **7.4 Fill Material and Compaction Requirements** section of this report.
Modulus of subgrade reaction [1]	125 psi/in for point loading conditions.
Capillary water barrier	Minimum of 4 inches of free draining granular material.

1. From Table 4-1 in UFC 3-320-06A, *Concrete Floor Slabs on Grade Subjected to Heavy Loads*, March 2005 for silts and clays with Liquid Limit less than 50 and moisture content of 17 to 20 percent.

Slab-on-grade subgrades must be moisture conditioned and properly compacted to the recommendations in this report immediately prior to placement of the capillary water barrier and concrete. Place a vapor barrier beneath concrete slabs-on-grade that will be covered with moisture sensitive or impervious coverings, or if the slab will support equipment sensitive to moisture. Place the vapor barrier between the capillary water barrier and floor slab subgrade. Isolate slabs-on-grade from structures and utilities to allow for their independent movement.

11.0 Pavements

Pavement subgrades must consist of at least 12 inches of on-site soils or structural fill prepared in accordance with the recommendations presented in **7.4 Fill Material and Compaction Requirements**. In areas of cut, this layer can be formed by reworking and recompacting the on-site soils at the subgrade level. In areas of fill, this layer can be formed incidentally due to site grading. Design recommendations for pavements have been summarized in the following table.

Pavement Design Recommendations	
California Bearing Ratio (CBR) [1]	2.5
Modulus of subgrade reaction (k) [2]	125 psi/in

1. For design, it is recommended the CBR value not exceed the typical design value listed in this table.
2. From Table 10-1 in UFC 3-250-01, *Pavement Design for Roads and Parking Areas*, November 2016. For silts and clays with Liquid Limit less than 50 and moisture content of 17 to 20 percent.

Construction scheduling can involve a time lapse between the end of grading operations and the commencement of paving. Disturbance, desiccation, or wetting of the subgrade soils between grading and paving can result in deterioration of the previously completed subgrade. A non-

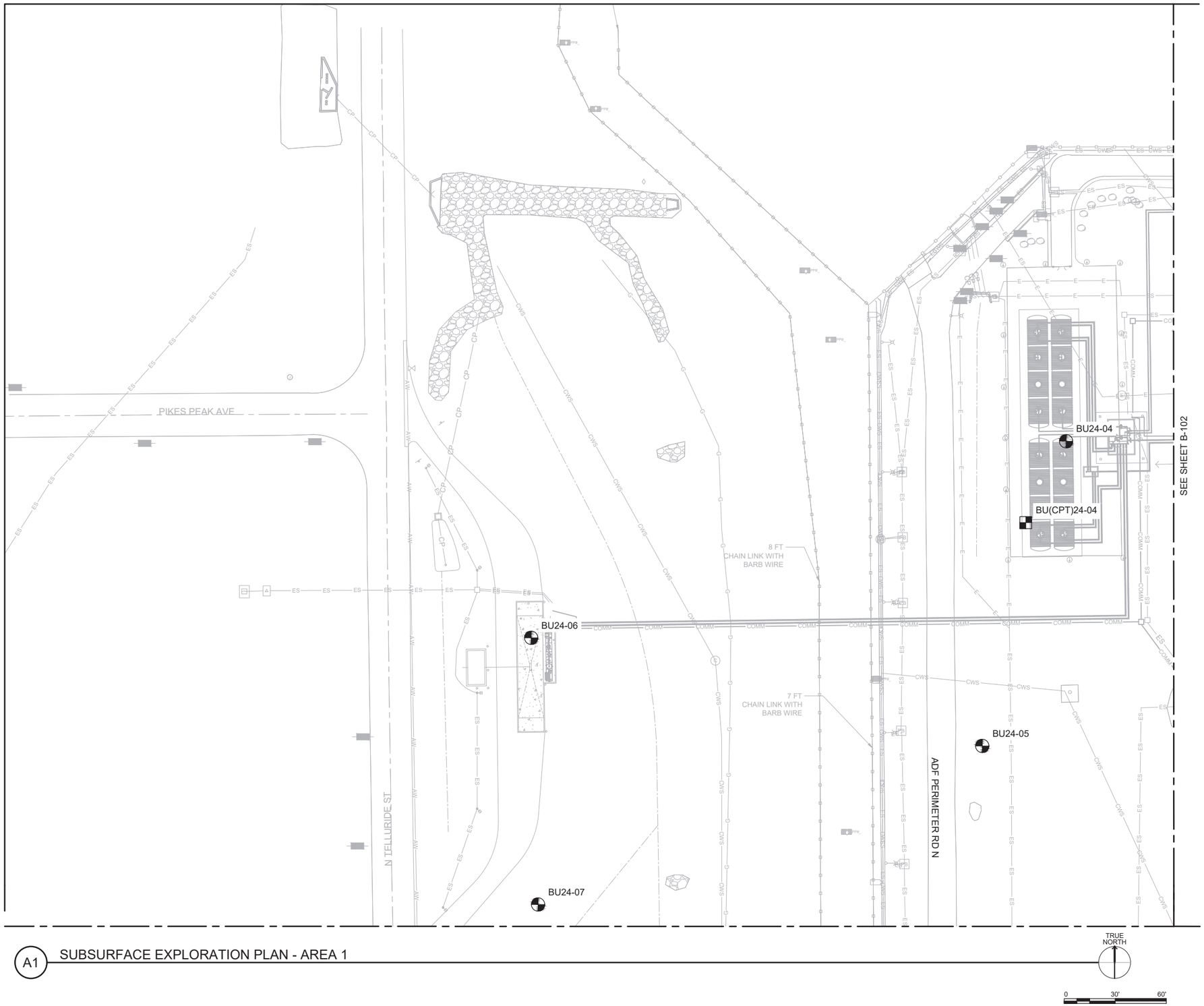
uniform subgrade can result in poor pavement performance and local failures relatively soon after pavements are constructed. Evaluate the moisture content and density of the subgrade within two days prior to commencement of actual paving operations. A proof roll using heavy equipment similar to that used for pavement construction is recommended to verify subgrade stability for pavement construction. Deflecting or rutting subgrade is to be reworked or otherwise improved to bring performance within tolerance. If the area is too soft to achieve adequate compaction, the subgrade can be reinforced with a tri-axial geogrid with a minimum radial stiffness of 15,000 pounds/foot. A layer of 1.5-inch (minus) crushed aggregate between 6 and 12 inches thick may be placed over the geogrid for particularly soft zones.

Preventing subgrade saturation is an important factor in maintaining the subgrade strength. Water allowed to pond on or next to pavements could saturate the subgrade and cause premature pavement deterioration. Provide positive surface drainage away from the edges of paved areas and slope all pavements to provide rapid surface drainage. Pavements should drain toward their perimeter rather than the center of the pavement, and perimeter surface drains should be installed next to areas where surface water could pond.

12.0 General Comments

The recommendations made in this report are based upon understanding of the project and the data obtained from the site. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, contact the geotechnical engineer to provide further evaluation and supplemental recommendations. It is critical that all recommendations in this report are taken into consideration for design purposes and during construction. Construction representatives and project engineers must assume responsibility for using appropriate practices. If changes in the nature, design, or location of the project are planned, the conclusions and recommendations in this report shall not be considered valid unless the changes are reviewed and either verified or modified by the geotechnical engineer.

Appendix A – Boring Location Plan



A1 SUBSURFACE EXPLORATION PLAN - AREA 1

GENERAL NOTES

1. SEE SHEETS B-301 TO B-304 FOR BORING AND CONE PENETRATION TEST (CPT) LOGS.
2. COORDINATE SYSTEM: COLORADO CENTRAL (0502). DATUM: NAVD88, NAD83.

EXPLORATION COORDINATES

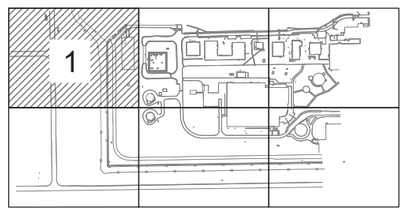
POINT	NORTHING	EASTING	DEPTH (FT)
BU24-04	3202528.281	1686375.559	20.0
BU24-05	3202479.059	1686196.673	20.0
BU24-06	3202214.107	1686260.145	20.0
BU24-07	3202218.159	1686103.538	20.0
BU(CPT)24-04	3202504.578	1686327.797	41.3

LEGEND

- SOIL BORING
- CONE PENETRATION TEST (CPT) SOUNDING

KEY PLAN

SCALE:1" = 400'



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MARK	DESCRIPTION	DATE

DESIGNED BY: R. SISK
DRAWN BY: R. SISK
CHECKED BY: K. HALL
SUBMITTED BY: K. HALL
APPROVED BY: ANS D.

ISSUE DATE: 01/17/2025
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:
FILENAME: BUCO00102B101-102.dwg

U.S. ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVE
OMAHA, NE 68102

BUCKLEY SFB, COLORADO
POWER INDEPENDENCE, MISSION CONTROL STATION

SUBSURFACE EXPLORATION PLAN - AREA 1

SHEET ID
B-101

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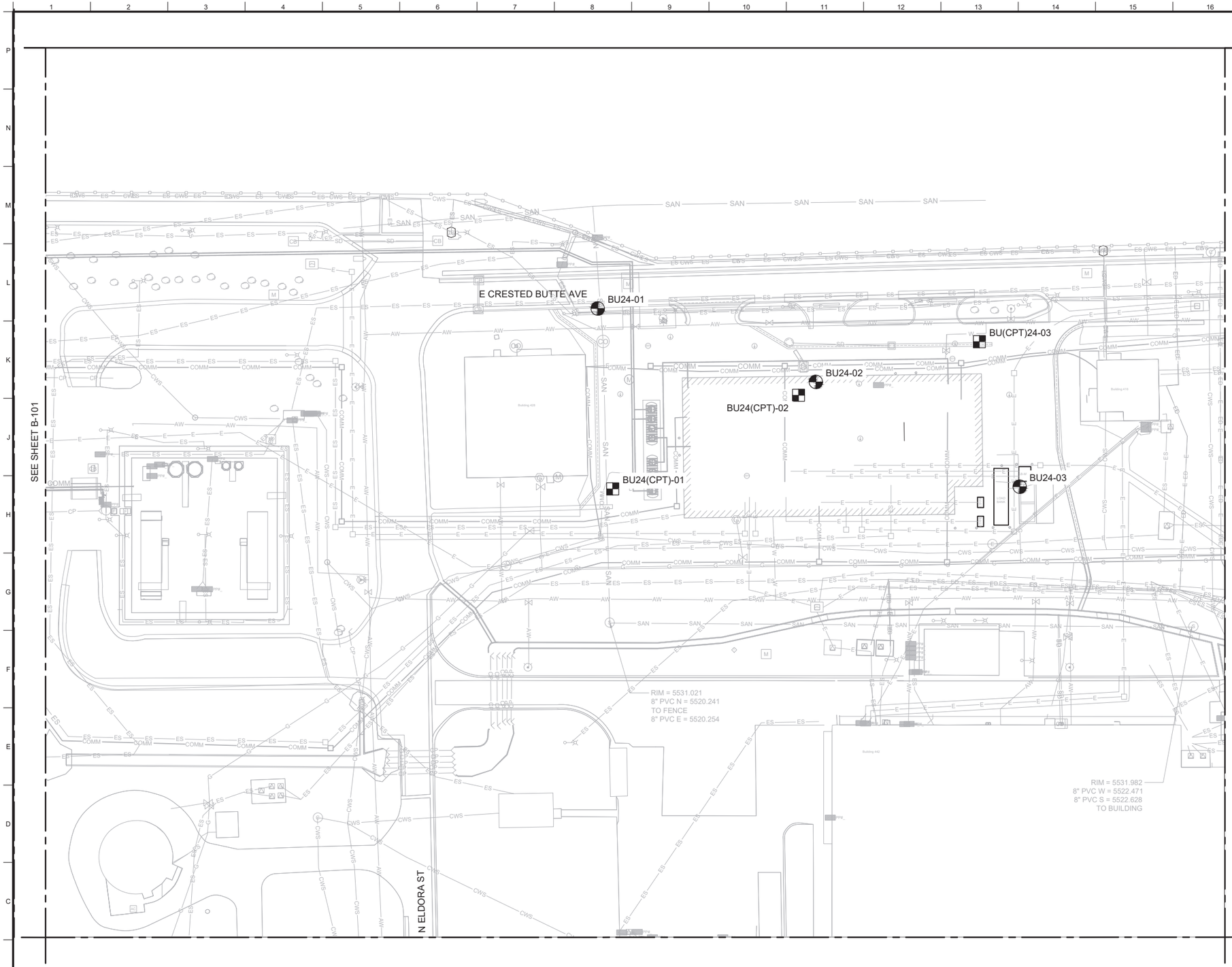
AEC_NCS_5_MONO.CTB
3:47:39 PM 1/8/2025

95% DESIGN



A1 SUBSURFACE EXPLORATION PLAN - AREA 2

GENERAL NOTES

1. SEE SHEETS B-301 TO B-304 FOR BORING AND CONE PENETRATION TEST (CPT) LOGS.
2. COORDINATE SYSTEM: COLORADO CENTRAL (0502). DATUM: NAVD88, NAD83.

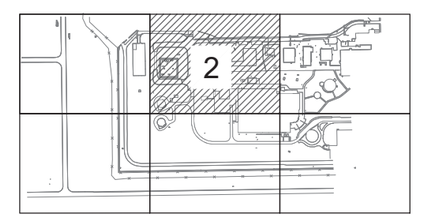
EXPLORATION COORDINATES

POINT	NORTHING	EASTING	DEPTH (FT)
BU24-01	3202912.867	1686480.607	71.2
BU24-02	3203039.804	1686437.902	98.4
BU24-03	3203158.446	1686376.918	78.6
BU(CPT)24-01	3202921.521	1686375.655	52.7
BU(CPT)24-02	3203029.709	1686430.136	54.2
BU(CPT)24-03	3203134.960	1686461.316	66.0

LEGEND

- SOIL BORING
- CONE PENETRATION TEST (CPT) SOUNDING

KEY PLAN



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MARK	DESCRIPTION	DATE

DESIGNED BY: R. SISK	ISSUE DATE: 01/17/2025
DRAWN BY: R. SISK	SOLICITATION NO.:
CHECKED BY: K. HALL	CONTRACT NO.:
SUBMITTED BY: K. HALL	FILE NUMBER:
SIZE: ANSI D	FILENAME: BUCO00102B101-102.dwg

U.S. ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVE
OMAHA, NE 68102

BUCKLEY SFB, COLORADO
POWER INDEPENDENCE, MISSION CONTROL STATION

SUBSURFACE EXPLORATION PLAN - AREA 2

SHEET ID
B-102

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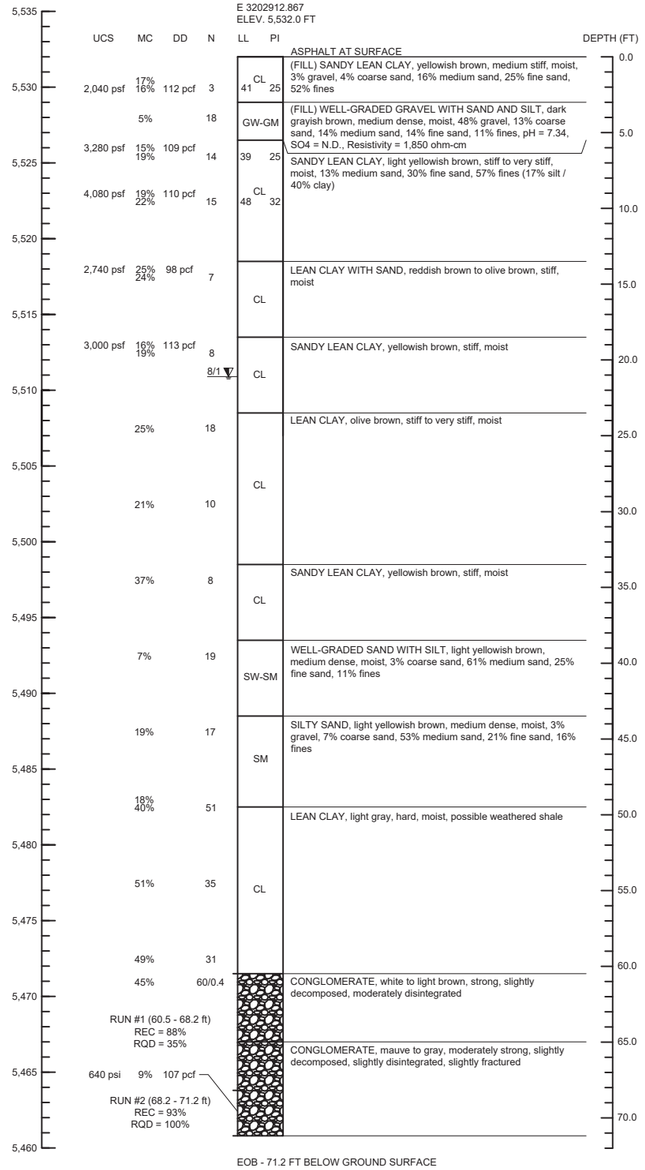
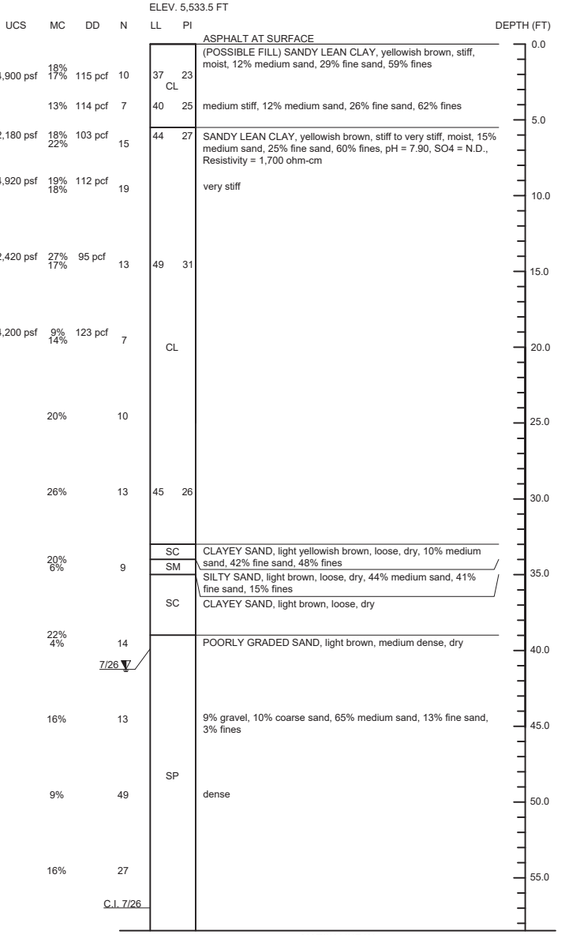
95% DESIGN

Appendix B – Boring and CPT Logs



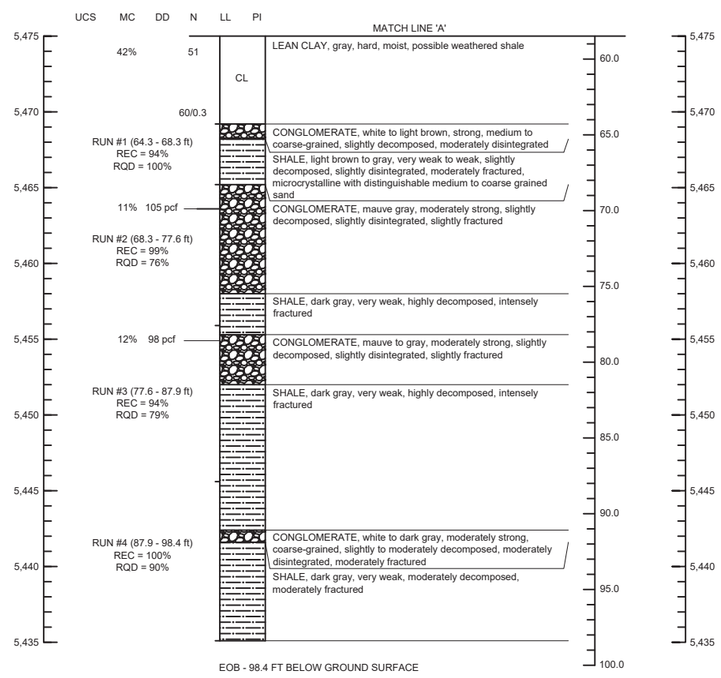


BORING NOTES

1. THE DESCRIPTIONS AT THE RIGHT OF THE LOGS ARE THE RESULTS OF FIELD AND LABORATORY DATA. THE TERMS "DRY", "MOIST", "WET", ETC. ARE FIELD DESCRIPTIONS MADE BY THE GEOLOGIST IN THE FIELD AT THE TIME OF DRILLING. SEE "MC" ON THE CONDENSED LOG OF BORINGS FOR LABORATORY DETERMINATION OF MOISTURE CONTENTS FOR THE SOIL. LABORATORY CLASSIFICATIONS ARE IN ACCORDANCE WITH ASTM D 2487.
2. THE LOGS FURNISHED REPRESENT THE TYPES OF SOIL AND ROCK ENCOUNTERED AT THEIR RESPECTIVE LOCATIONS AND THE WATER LEVEL ENCOUNTERED AT THAT TIME. THE BORING LOGS ARE CONSIDERED REPRESENTATIVE OF THE SOILS WHICH WERE ENCOUNTERED AT THAT LOCATION; HOWEVER, WATER LEVELS CAN FLUCTUATE APPRECIABLY AT DIFFERENT SEASONS OF THE YEAR OR FROM YEAR TO YEAR DEPENDING LARGELY ON CLIMATIC CONDITIONS. THE CONTRACTOR SHOULD IDENTIFY GROUNDWATER CONDITIONS PRIOR TO THE TIME OF CONSTRUCTION.
3. REFUSAL IS DEFINED AS A CUMULATIVE BLOW COUNT EXCEEDING 60 IN ANY SIX-INCH INTERVAL OF THE STANDARD PENETRATION TEST (SPT). ONCE REFUSAL WAS ENCOUNTERED, THE SPT WAS DISCONTINUED.
4. FOR SOIL BORING LOCATIONS, SEE SHEET B-101.
5. COORDINATE SYSTEM: COLORADO CENTRAL STATE PLANE (0502)
   DATUM: NAVD88, NAD83

BORING LEGEND

BU24-01	BORING NUMBER
JULY 31, 2024	DATE BORING COMPLETED
N 1686480.607 E 3202912.867	UNITED STATES STATE PLANE COORDINATES, US SURVEY FEET, ZONE 0502, COLORADO CENTRAL
ELEV. 5,532.0 FT	TOP OF BORING ELEVATION ROUNDED TO NEAREST HALF-FOOT (NAVD88)
UCS	UNCONFINED COMPRESSIVE STRENGTH (ASTM D2166 / D7012)
MC	NATURAL MOISTURE CONTENT IN PERCENT (ASTM D2216)
DD	DRY UNIT WEIGHT OF SOIL (ASTM D7263)
LL	LIQUID LIMIT (ASTM D4318)
PI	PLASTICITY INDEX (ASTM D4318)
N	STANDARD PENETRATION BLOW COUNT. NUMBER OF BLOWS FOR A 140-POUND WEIGHT DROPPING 30 INCHES TO DRIVE A 2-INCH OUTSIDE DIAMETER SAMPLER 1 FOOT.
% fines	PERCENT OF SOIL BY DRY WEIGHT PASSING THE NO. 200 SIEVE (ASTM D422 / C136)
REC	ROCK CORE RECOVERY
RQD	ROCK QUALITY DESIGNATION
pH	pH VALUE FROM LAB ANALYSIS (ASTM G51)
SO4	WATER SOLUBLE SULFATE FROM LAB ANALYSIS (EPA 9056A)
ppm	PARTS PER MILLION
Resistivity	RESISTIVITY AS RECIPROCAL OF ELECTRICAL RESISTIVITY FROM LAB ANALYSIS (ASTM G57)
N.D.	NOT DETECTABLE
11/15 ▽	GROUNDWATER LEVEL IN BORING IMMEDIATELY AFTER DRILLING
11/16 ▼	GROUNDWATER LEVEL IN BORING 24 HOURS AFTER DRILLING
C.I. 4/22	BORING CAVE-IN DEPTH AND DATE MEASURED
EOB	END OF BORING



US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. SISK
DRAWN BY: R. SISK
CHECKED BY: K. HALL
SUBMITTED BY: K. HALL
SCALE: ANSI D
ISSUE DATE: 01/17/2025
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:
FILENAME: BUCO00102B101-102.dwg

U.S. ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVE
OMAHA, NE 68102

BUCKLEY SFB, COLORADO
POWER INDEPENDENCE, MISSION CONTROL STATION

SOIL BORING LOGS - 1 OF 2

SHEET ID
B-301

95% DESIGN

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AEC_NCS_5_MONO.CTB
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BU24-03
JULY 29, 2024
N 1686376.918
E 3203158.446
ELEV. 5,534.0 FT

UCS	MC	DD	N	LL	PI		DEPTH (FT)
						ASPHALT AT SURFACE	0.0
3,680 psf	22% 25%	101 pcf	12		CL	(POSSIBLE FILL) LEAN CLAY, reddish brown, stiff, moist, 2% medium sand, 7% fine sand, 44% silt, 47% clay, pH = 7.72, SO4 = 110 ppm, Resistivity = 1,000 ohm-cm	
5,300 psf	22% 17%	111 pcf	6				5.0
	15%		8	39	25	SANDY LEAN CLAY, reddish brown to gray, stiff to very stiff, moist, 14% medium sand, 28% fine sand, 58% fines	
4,900 psf	19% 20%	103 pcf	17	39	23 CL	9% medium sand, 23% fine sand, 68% fines	10.0
3,260 psf	28% 30%	92 pcf	11		CL	LEAN CLAY WITH SAND, light gray, stiff, moist	15.0
3,180 psf	24% 22%	98 pcf	7		CL	LEAN CLAY, reddish brown, medium stiff, moist	20.0
	23%		18	48	29	SANDY LEAN CLAY, light yellowish brown, stiff to very stiff, moist, 1% coarse sand, 6% medium sand, 28% fine sand, 65% fines	
	21%		12		CL		30.0
			7/30				
	20% 9%		20			POORLY GRADED SAND, light brown to light gray, medium dense, moist	35.0
	22% 4%		28			2% gravel, 9% coarse sand, 69% medium sand, 16% fine sand, 4% fines	40.0
			7/26		SP		
	17%		18				45.0
	16%		29				50.0
	44%		52			LEAN CLAY, gray, hard, moist, possible weathered shale	55.0
	43%		46		CL		60.0
	38%		60				65.0
			60/0.3			CONGLOMERATE, white to light brown, strong, coarse-grained, slightly decomposed, slightly to moderately disintegrated, intensely fractured	70.0
720 psi	10%	102 pcf				CONGLOMERATE, gray, strong, competent, slightly fractured	
RUN #1 (68.3 - 78.6 ft) REC = 93% RQD = 90%							75.0
							80.0

EOB - 78.6 FT BELOW GROUND SURFACE

BU24-04
AUGUST 3, 2024
N 1686375.559
E 3202528.281
ELEV. 5,524.5 FT

MC	N	LL	PI		DEPTH (FT)
				CONCRETE AT SURFACE	0.0
20%	11	38	21 CL	LEAN CLAY WITH SAND, grayish brown, stiff, moist, 3% coarse sand, 9% medium sand, 13% fine sand, 75% fines	
20%	11			pH = 9.54, SO4 = 481 ppm, Resistivity = 1,100 ohm-cm	5.0
20%	8	44	27 CL	LEAN CLAY WITH SAND, light olive brown, medium stiff to stiff, moist, 1% coarse sand, 7% medium sand, 14% fine sand, 78% fines	
22%	20		CL	LEAN CLAY, yellowish brown, very stiff, moist	10.0
12%	10		CL	SANDY LEAN CLAY, grayish brown, stiff, moist	15.0
C.I. 8/3					
19%	13		CL	LEAN CLAY WITH SAND, light yellowish brown, stiff, moist	20.0

EOB - 20.0 FT BELOW GROUND SURFACE
GROUNDWATER NOT ENCOUNTERED

BU24-05
AUGUST 2, 2024
N 1686196.673
E 3202479.059
ELEV. 5,525.0 FT

MC	N	LL	PI		DEPTH (FT)
				CONCRETE AT SURFACE	0.0
21%	14		CL	LEAN CLAY, grayish brown to light gray, stiff, moist	
20%	8	40	22	1% medium sand, 6% fine sand, 93% fines, pH = 7.61, SO4 = N.D., Resistivity = 1,000 ohm-cm	5.0
19%	15	41	25	SANDY LEAN CLAY, light olive brown, stiff, moist, 7% medium sand, 32% fine sand, 61% fines	
15%	13		CL		10.0
14%	7			CLAYEY SAND, olive brown, loose to medium dense, moist	15.0
C.I. 8/2			SC		
11%	14				20.0

EOB - 20.0 FT BELOW GROUND SURFACE
GROUNDWATER NOT ENCOUNTERED

BU24-06
AUGUST 5, 2024
N 1686260.145
E 3202214.107
ELEV. 5,520.0 FT

MC	N	LL	PI		DEPTH (FT)
				VEGETATION AT SURFACE	0.0
9%	25			SILTY LEAN CLAY, yellowish brown, stiff to very stiff, moist	
13%	10				5.0
12%	2		CL-ML	soft at about 6 ft.	
10%	19				10.0
8%	19			POORLY GRADED SAND WITH CLAY, light yellowish brown, medium dense, moist	15.0
C.I. 8/5			SP		
12%	23				20.0

EOB - 20.0 FT BELOW GROUND SURFACE
GROUNDWATER NOT ENCOUNTERED

BU24-07
AUGUST 5, 2024
N 1686103.538
E 3202218.159
ELEV. 5,524.0 FT

MC	N	LL	PI		DEPTH (FT)
				VEGETATION AT SURFACE	0.0
9%	15			SILTY LEAN CLAY, yellowish brown to grayish brown, very stiff, dry to moist	
13%	22				5.0
13%	19		CL-ML		
13%	21				10.0
8%	18			POORLY GRADED SAND WITH CLAY, light yellowish brown, medium dense, moist	15.0
C.I. 8/5			SP		
6%	23				20.0

EOB - 20.0 FT BELOW GROUND SURFACE
GROUNDWATER NOT ENCOUNTERED

BORING NOTES

1. SEE SHEET B-301 FOR NOTES.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. SISK
DRAWN BY: R. SISK
CHECKED BY: K. HALL
SUBMITTED BY: K. HALL
SIZE: ANSI D
ISSUE DATE: 01/17/2025
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:
FILENAME: BUCO00102B101-102.dwg

U.S. ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVE
OMAHA, NE 68102

BUCKLEY SFB, COLORADO
POWER INDEPENDENCE, MISSION CONTROL STATION

SOIL BORING LOGS - 2 OF 2

SHEET ID
B-302

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AEC_NCS_5_MONO.CTB
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95% DESIGN

Test name	Depth [ft]	Company name	Scale
BU(CPT)24-01	52.7		
Nominal surface area of cone tip [cm²]	Cone name	Start date	Page
15.0	5891	7/24/2024	1/3
Remarks1			

US Army Corps of Engineers® Omaha District

Classification by Robertson 1990 — qt [t/ft²] — fs [t/ft²] — u2 [t/ft²] — N60 [] — Su(qc) [t/ft²]

Clayey silt to silty clay
Very stiff sand to clayey sand
Very stiff fine grained
Clayey silt to silty clay
Very stiff fine grained
Clayey silt to silty clay
Clays, clay to silty clay
Clayey silt to silty clay
Clays, clay to silty clay
Clays, clay to silty clay

Depth [ft]

— qc [t/ft²] — Su(qt,WL) [t/ft²]

Test name	Depth [ft]	Company name	Scale
BU(CPT)24-01	52.7		
Nominal surface area of cone tip [cm²]	Cone name	Start date	Page
15.0	5891	7/24/2024	2/3
Remarks1			

US Army Corps of Engineers® Omaha District

Classification by Robertson 1990 — qt [t/ft²] — fs [t/ft²] — u2 [t/ft²] — N60 [] — Su(qc) [t/ft²]

Clays, clay to silty clay
Clayey silt to silty clay
Silty sand to sandy silt
Clayey silt to silty clay
Silty sand to sandy silt
Clayey silt to silty clay
Clays, clay to silty clay
Clays, clay to silty clay
Silty sand to sandy silt
Silty sand to sandy silt
Clean sands to silty sands
Silty sand to sandy silt
Clean sands to silty sands
Clayey silt to silty clay
Silty sand to sandy silt

Depth [ft]

— qc [t/ft²] — Su(qt,WL) [t/ft²]

Test name	Depth [ft]	Company name	Scale
BU(CPT)24-01	52.7		
Nominal surface area of cone tip [cm²]	Cone name	Start date	Page
15.0	5891	7/24/2024	3/3
Remarks1			

US Army Corps of Engineers® Omaha District

Classification by Robertson 1990 — qt [t/ft²] — fs [t/ft²] — u2 [t/ft²] — N60 [] — Su(qc) [t/ft²]

Clayey silt to silty clay

Depth [ft]

— qc [t/ft²] — Su(qt,WL) [t/ft²]

Test name	Depth [ft]	Company name	Scale
BU(CPT)24-02	54.2		
Nominal surface area of cone tip [cm²]	Cone name	Start date	Page
15.0	5891	7/24/2024	1/3
Remarks1			

US Army Corps of Engineers® Omaha District

Classification by Robertson 1990 — qt [t/ft²] — fs [t/ft²] — u2 [t/ft²] — N60 [] — Su(qc) [t/ft²]

Clays, clay to silty clay
Clayey silt to silty clay
Clays, clay to silty clay
Clays, clay to silty clay
Clean sands to silty sands
Clayey silt to silty clay
Clays, clay to silty clay
Clayey silt to silty clay
Clays, clay to silty clay
Clays, clay to silty clay
Clayey silt to silty clay
Clays, clay to silty clay

Depth [ft]

— qc [t/ft²] — Su(qt,WL) [t/ft²]

Test name	Depth [ft]	Company name	Scale
BU(CPT)24-02	54.2		
Nominal surface area of cone tip [cm²]	Cone name	Start date	Page
15.0	5891	7/24/2024	2/3
Remarks1			

US Army Corps of Engineers® Omaha District

Classification by Robertson 1990 — qt [t/ft²] — fs [t/ft²] — u2 [t/ft²] — N60 [] — Su(qc) [t/ft²]

Clays, clay to silty clay
Clayey silt to silty clay
Silty sand to sandy silt
Clayey silt to silty clay
Clean sands to silty sands
Clays, clay to silty clay
Clean sands to silty sands
Silty sand to sandy silt
Clean sands to silty sands
Clays, clay to silty clay
Clayey silt to silty clay
Silty sand to sandy silt
Clean sands to silty sands

Depth [ft]

— qc [t/ft²] — Su(qt,WL) [t/ft²]

Test name	Depth [ft]	Company name	Scale
BU(CPT)24-02	54.2		
Nominal surface area of cone tip [cm²]	Cone name	Start date	Page
15.0	5891	7/24/2024	3/3
Remarks1			

US Army Corps of Engineers® Omaha District

Classification by Robertson 1990 — qt [t/ft²] — fs [t/ft²] — u2 [t/ft²] — N60 [] — Su(qc) [t/ft²]

Clean sands to silty sands
Silty sand to sandy silt

Depth [ft]

— qc [t/ft²] — Su(qt,WL) [t/ft²]

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: D. BASNER
DRAWN BY: D. BASNER
CHECKED BY: R. SISK
SUBMITTED BY: K. HALL
SCALE: ANSI D

ISSUE DATE: 01/17/2025
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:
FILENAME: BUCO00102B101-102.dwg

U.S. ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVE
OMAHA, NE 68102

BUCKLEY SFB, COLORADO
POWER INDEPENDENCE, MISSION CONTROL STATION

CONE PENETRATION TEST LOGS - 1 OF 2

SHEET ID
B-303

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AEC_NCS_5_MONO.CTB
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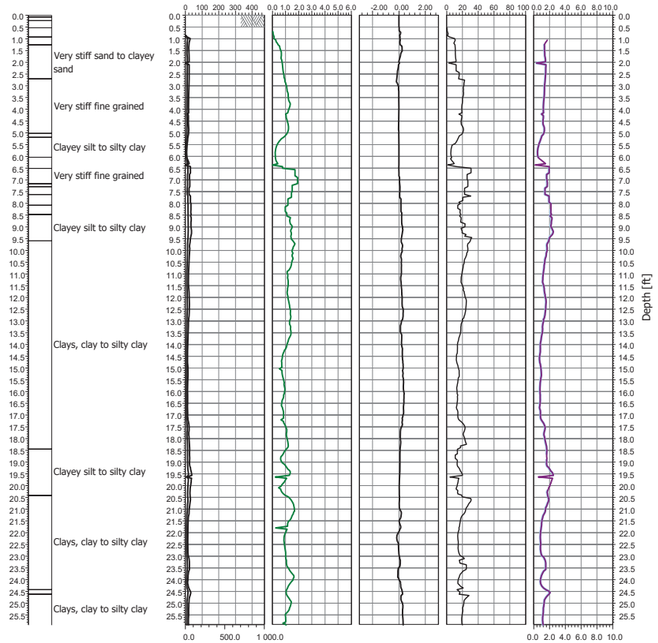
95% DESIGN

Test name	Depth [ft]	Company name	Scale
BU(CPT)24-01	52.7		
Nominal surface area of cone tip [cm²]	Cone name	Start date	Page
15.0	5891	7/24/2024	1/3
Remarks1			

US Army Corps of Engineers® Omaha District

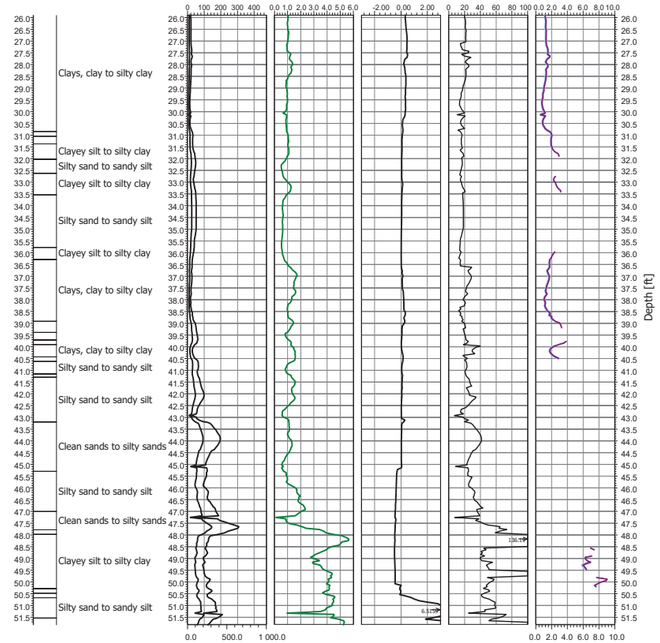
Classification by Robertson 1990 — qt [t/ft²] — fs [t/ft²] — u2 [t/ft²] — N60 [] — Su(qc) [t/ft²]



Test name	Depth [ft]	Company name	Scale
BU(CPT)24-01	52.7		
Nominal surface area of cone tip [cm²]	Cone name	Start date	Page
15.0	5891	7/24/2024	2/3
Remarks1			

US Army Corps of Engineers® Omaha District

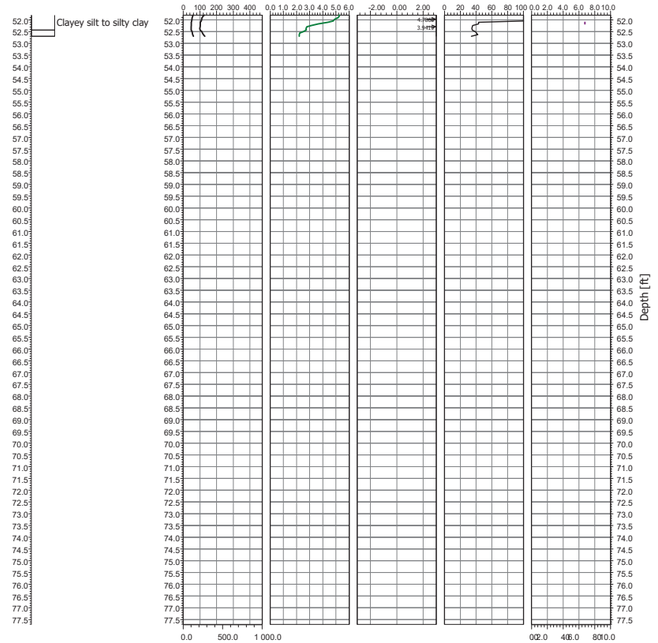
Classification by Robertson 1990 — qt [t/ft²] — fs [t/ft²] — u2 [t/ft²] — N60 [] — Su(qc) [t/ft²]



Test name	Depth [ft]	Company name	Scale
BU(CPT)24-01	52.7		
Nominal surface area of cone tip [cm²]	Cone name	Start date	Page
15.0	5891	7/24/2024	3/3
Remarks1			

US Army Corps of Engineers® Omaha District

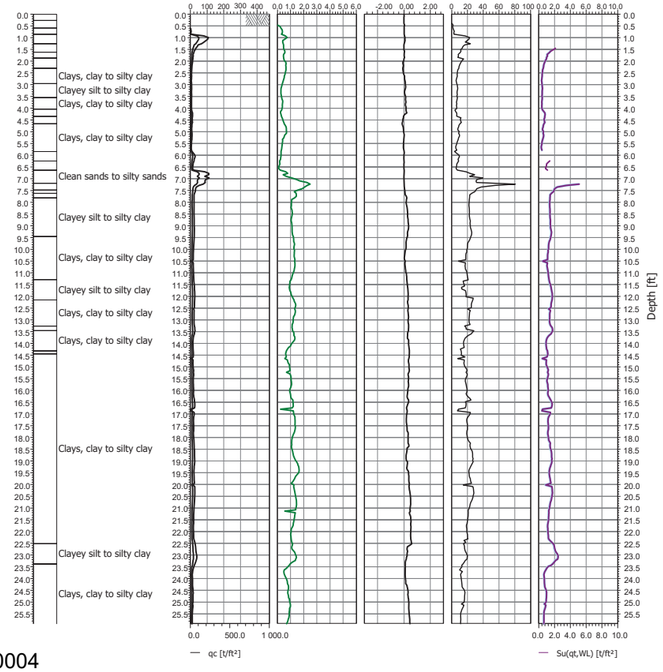
Classification by Robertson 1990 — qt [t/ft²] — fs [t/ft²] — u2 [t/ft²] — N60 [] — Su(qc) [t/ft²]



Test name	Depth [ft]	Company name	Scale
BU(CPT)24-02	54.2		
Nominal surface area of cone tip [cm²]	Cone name	Start date	Page
15.0	5891	7/24/2024	1/3
Remarks1			

US Army Corps of Engineers® Omaha District

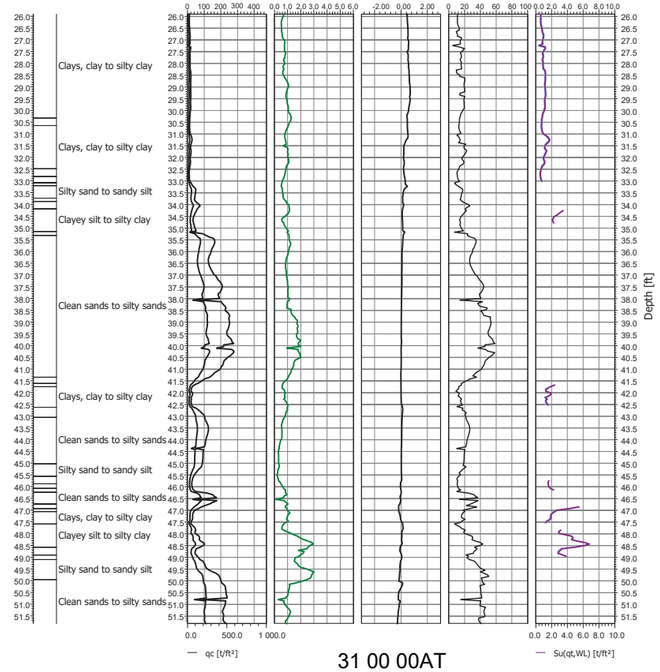
Classification by Robertson 1990 — qt [t/ft²] — fs [t/ft²] — u2 [t/ft²] — N60 [] — Su(qc) [t/ft²]



Test name	Depth [ft]	Company name	Scale
BU(CPT)24-02	54.2		
Nominal surface area of cone tip [cm²]	Cone name	Start date	Page
15.0	5891	7/24/2024	2/3
Remarks1			

US Army Corps of Engineers® Omaha District

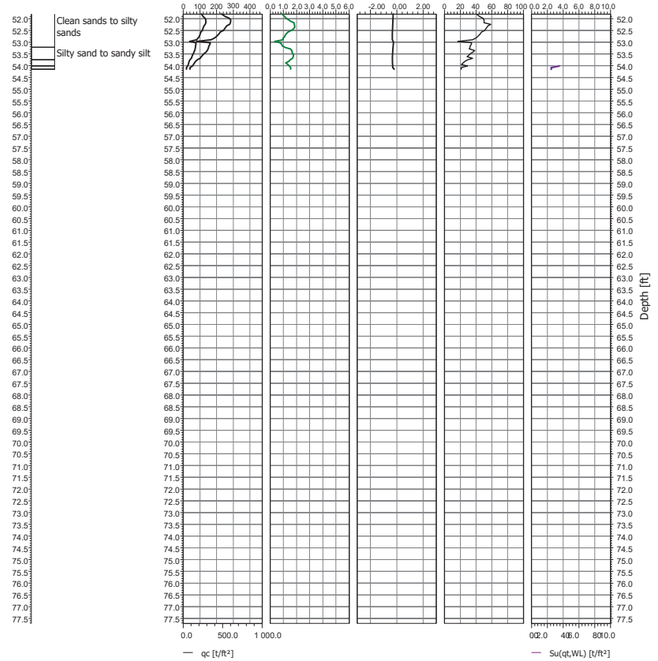
Classification by Robertson 1990 — qt [t/ft²] — fs [t/ft²] — u2 [t/ft²] — N60 [] — Su(qc) [t/ft²]



Test name	Depth [ft]	Company name	Scale
BU(CPT)24-02	54.2		
Nominal surface area of cone tip [cm²]	Cone name	Start date	Page
15.0	5891	7/24/2024	3/3
Remarks1			

US Army Corps of Engineers® Omaha District

Classification by Robertson 1990 — qt [t/ft²] — fs [t/ft²] — u2 [t/ft²] — N60 [] — Su(qc) [t/ft²]



US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: D. BASNER
DRAWN BY: D. BASNER
CHECKED BY: R. SISK
SUBMITTED BY: K. HALL
SCALE: ANSI D

ISSUE DATE: 01/17/2025
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:
FILENAME: BUCO0102B101-102.dwg

U.S. ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVE
OMAHA, NE 68102

BUCKLEY SFB, COLORADO
POWER INDEPENDENCE, MISSION CONTROL STATION

CONE PENETRATION TEST LOGS - 2 OF 2

SHEET ID
B-304

95% DESIGN

P:\BUCO00102\PLAN SETS\03_SHEETS\03_SITE\BUCO00102B301-304.DWG
G\EDX\RS6
AEC_NCS_5_MONO.CTB
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Appendix C – Laboratory Test Results

PIMCS Buckley SFB Soil Testing

Buckley SFB, Colorado

Terracon Project No. 05241404

Boring and Sample Nos.	Depth (ft)	Descriptions	USCS	Sieve % Passing										Atterberg			Moisture Content	Dry Density	UC Value	RC UC Value	Q.P.	Swell Method C	Required Tests
				1"	3/4"	1/2"	3/8"	#4	#10	#20	#40	#80	#200	LL	PL	PI	%	PCF	tsf	psi		%	
BU24-01 D-1	1.0-2.5	10YR 5/4 Yellowish Brown Sandy Lean Clay	CL			100.0	98.4	96.7	92.5	87.7	76.7	62.7	52.0	41	16	25	16.7						MC, Visual Class, AL, MA
D-2	3.0-4.5	10YR 4/2 Dark Grayish Brown Well Graded Gravel with Silt and Sand	GW-GM	100.0	96.2	81.7	73.1	52.2	39.0	30.7	24.9	17.2	10.9				4.6						MC, Visual Class, MA, Chem Testing
D-3	5.5-7.0	10YR 6/4 Light Yellowish Brown Sandy Lean Clay	CL					100.0	99.8	97.3	86.8	70.0	57.0	39	14	25	18.5						MC, Visual Class, AL, Hydro
D-4	8.5-10.0	10YR 6/4 Light Yellowish Brown Lean Clay	CL											48	16	32	21.8						MC, Visual Class, AL
D-5	13.5-15.0	5YR 5/3 Reddish Brown Lean Clay															23.5						MC, Visual Class
D-6	18.5-20.0	10YR 5/4 Yellowish Brown Sandy Lean Clay															18.6						MC, Visual Class
D-7	23.5-25.0	2.5 5/3 Light Olive Brown Lean Clay															24.5						MC, Visual Class
D-8	28.5-30.0	2.5 5/3 Light Olive Brown Lean Clay															20.7						MC, Visual Class
D-9	33.5-35.0	10YR 6/4 Light Yellowish Brown Sandy Lean Clay															37.3						MC, Visual Class
D-10	38.5-40.0	10YR 6/4 Light Yellowish Brown Well Graded Sand with Silt	SW-SM					100.0	96.8	70.7	35.6	15.3	10.6				6.5						MC, Visual Class, MA
D-11	43.5-45.0	10YR 6/4 Light Yellowish Brown Clayey Sand	SC			100.0	99.3	97.3	89.7	65.3	37.0	20.5	15.9				18.8						MC, Visual Class, MA
D-12	48.5-49.4	2.5Y 6/1 Gray Poorly Graded Sand															18.0						MC, Visual Class
D-13	49.4-50.0	2.5Y 6/1 Gray Poorly Graded Sand															39.5						MC, Visual Class
D-14	53.5-55.0	2.5Y 6/1 Gray Weathered Shale (Lean Clay)															51.3						MC, Visual Class
D-15	58.5-60.0	2.5Y 7/1 Light Gray Shale (Lean Clay)															48.8						MC, Visual Class
D-16	61.0-61.4	2.5Y 7/1 Light Gray Shale (Lean Clay)															44.9						MC, Visual Class
U-1	1.0-3.0	10YR 6/3 Pale Brown Sandy Lean Clay															15.8	111.7	1.02		1.75		MC, Visual Class, Density, UC, QP
U-2	5.0-7.0	10YR 6/3 Pale Brown Sandy Lean Clay															14.7	109.4	1.64		3.75		MC, Visual Class, Density, UC, QP
U-3	8.0-10.0	10YR 5/4 Yellowish Brown Sandy Lean Clay															19.1	109.8	2.04		3.50		MC, Visual Class, Density, UC, QP
U-4	13.0-15.0	2.5Y 4/3 Olive Brown Lean Clay with Sand															25.4	97.5	1.37		2.75		MC, Visual Class, Density, UC, QP
U-5	18.0-20.0	10YR 6/3 Pale Brown Sandy Lean Clay															16.0	112.5	1.50		3.00		MC, Visual Class, Density, UC, QP
Run 2 Core	69.6'	5Y Olive Gray 4/2 Andesite															9.4	106.9		640			Rock Core UC (ASTM D7012)

PIMCS Buckley SFB Soil Testing

Buckley SFB, Colorado

Terracon Project No. 05241404

Boring and Sample Nos.	Depth (ft)	Descriptions	USCS	Sieve % Passing										Atterberg			Moisture Content	Dry Density	UC Value	RC UC Value	Q.P.	Swell Method C	Required Tests
				1"	3/4"	1/2"	3/8"	#4	#10	#20	#40	#80	#200	LL	PL	PI	%	PCF	tsf	psi		%	
BU24-02 D-1	1.0-2.5	5YR 5/6 Yellowish Red Sandy Lean Clay															18.4						MC, Visual Class
D-2	5.5-7.0	10YR 6/6 Brownish Yellow Lean Clay															21.8						MC, Visual Class, Chem Testing
D-3	8.5-10.0	10YR 6/6 Brownish Yellow Lean Clay															18.1						MC, Visual Class
D-4	13.5-15.0	10YR 6/6 Brownish Yellow Lean Clay	CL											49	18	31	16.8						MC, Visual Class, AL
D-5	18.5-20.0	10YR 6/6 Brownish Yellow Clayey Sand															14.4						MC, Visual Class
D-6	23.5-25.0	2.5Y 4/3 Olive Brown Sandy Lean Clay															19.8						MC, Visual Class
D-7	28.5-30.0	2.5Y 6/3 Light Yellowish Brown	CL											45	19	26	25.6						MC, Visual Class, AL
D-8	33.5-34.0	2.5Y 6/3 Light Yellowish Brown Clayey Sand	SC					100.0	99.8	98.8	89.7	64.8	47.6				20.2						MC, Visual Class, MA
D-9	34.0-35.0	10YR 6/3 Pale Brown Silty Sand	SM				####	99.8	99.5	91.6	55.4	22.1	14.5				5.6						MC, Visual Class, MA
D-10	38.5-39.0	10YR 6/3 Pale Brown Clayey Sand															21.9						MC, Visual Class
D-11	39.0-40.0	2.5Y 7/4 Pale Brown Poorly Graded Sand															3.6						MC, Visual Class
D-12	43.5-45.0	2.5Y 8/1 White Poorly Graded Sand	SP	100.0	95.4	95.4	94.9	91.3	80.8	48.2	15.4	4.6	2.5				16.3						MC, Visual Class, MA
D-13	48.5-50.0	2.5Y 7/3 Pale Brown Poorly Graded Sand															8.6						MC, Visual Class
D-14	53.5-55.0	2.5Y 8/1 White Poorly Graded Sand															15.8						MC, Visual Class
D-15	58.5-60.0	5Y 7/2 Gray Shale (Lean Clay)															41.6						MC, Visual Class
U-1	1.0-3.0	10YR 5/6 Yellowish Brown Sandy Lean Clay	CL						100.0	98.0	88.0	72.0	58.8	37	14	23	16.7	114.7	2.45		3.75	0.651	MC, Visual Class, Density, UC, QP, AL, Hydro, Swell (Method C. Load to 250 psf)
U-2	3.0-5.0	10YR 4/6 Yellowish Brown Sandy Lean Clay	CL					100.0	99.9	98.1	87.7	72.4	62.1	40	15	25	12.7	113.5	N/A		3.75	0.000	MC, Visual Class, Density, AL, Hydro, Swell (Method C. Load to 2500 psf)
U-3	5.0-7.0	10YR 5/4 Yellowish Brown Sandy Lean Clay	CL					100.0	100.0	96.0	85.2	71.8	60.2	44	17	27	18.2	103.3	1.09		2.50	0.207	MC, Visual Class, Density, UC, QP, AL, Hydro, Swell (Method C. Load to 750 psf)
U-4	8.0-10.0	10YR 5/6 Yellowish Brown Lean Clay with Sand															18.7	111.7	2.46		4.00		MC, Visual Class, Density, UC, QP
U-5	13.0-15.0	2.5Y 5/6 Light Olive Brown Lean Clay with Sand															26.6	95.1	1.21		2.25		MC, Visual Class, Density, UC, QP
U-6	18.0-20.0	10YR 5/8 Yellowish Brown Clayey Sand															9.4	123.0	2.10		3.75		MC, Visual Class, Density, UC, QP

PIMCS Buckley SFB Soil Testing

Buckley SFB, Colorado

Terracon Project No. 05241404

Boring and Sample Nos.	Depth (ft)	Descriptions	USCS	Sieve % Passing										Atterberg			Moisture Content	Dry Density	UC Value	RC UC Value	Q.P.	Swell Method C	Required Tests
				1"	3/4"	1/2"	3/8"	#4	#10	#20	#40	#80	#200	LL	PL	PI	%	PCF	tsf	psi		%	
Run 2 Core	69.9'	5Y Olive Gray 4/2 Andesite															11.1	105.0		770			Rock Core UC (ASTM D7012)
Run 2 Core	78.6'	5Y Olive Gray 4/2 Andesite															12.0	98.0		810			Rock Core UC (ASTM D7012)
Run 2 Core	95'	2.5Y Light Yellowish Brown 6/4 Weathered Shale															18.6						MC
BU24-03 D-1	1.0-2.5	5YR 5/3 Reddish Brown Lean Clay							100.0	99.6	98.2	95.8	91.3				21.9						MC, Visual Class, Hydro, Chem Testing
D-2	3.0-4.5	10YR 5/3 Brown Lean Clay															22.0						MC, Visual Class
D-3	5.5-7.0	5YR 5/3 Reddish Brown Sandy Lean Clay	CL						100.0	97.8	85.6	69.4	57.7	39	14	25	15.0						MC, Visual Class, AL, MA
D-4	8.5-10.0	10YR 7/2 Light Gray Sandy Lean Clay	CL					100.0	99.8	98.0	90.9	77.8	68.2	39	16	23	19.9						MC, Visual Class, AL, MA
D-5	13.5-15.0	10YR 7/2 Light Gray Lean Clay with Sand															30.3						MC, Visual Class
D-6	18.5-20.0	5YR 5/3 Reddish Brown Lean Clay															21.7						MC, Visual Class
D-7	23.5-25.0	10YR 6/4 Light Yellowish Brown Sandy Lean Clay	CL					100.0	99.5	97.1	92.9	80.2	65.0	48	19	29	23.4						MC, Visual Class, AL, MA
D-8	28.5-30.0	10YR 5/3 Brown Lean Clay															21.3						MC, Visual Class
D-9	33.5-35.0	2.5Y 6/6 Olive Yellow Poorly Graded Sand															9.0						MC, Visual Class
D-10	38.5-40.0	10YR 6/3 Pale Brown Poorly Graded Sand	SP				100.0	97.9	88.8	53.8	20.5	7.3	4.4				3.8						MC, Visual Class, MA
D-11	43.5-45.0	10YR 6/3 Pale Brown Poorly Graded Sand															17.3						MC, Visual Class
D-12	48.5-50.0	10YR 7/1 Light Gray Poorly Graded Sand															16.1						MC, Visual Class
D-13	53.5-55	10YR 5/1 Gray Shale (Clayey Sand)															43.9						MC, Visual Class
D-14	58.5-60	10YR 5/1 Gray Shale (Clayey Sand)															43.1						MC, Visual Class
D-15	63.5-65.0	10YR 5/1 Gray Shale (Clayey Sand)															38.2						MC, Visual Class
U-1	1.0-3.0	10YR 4/4 Dark Yellowish Brown Lean Clay															24.7	101.1	1.84		2.50		MC, Visual Class, Density, UC, QP
U-2	3.0-5.0	10YR 5/6 Yellowish Brown Sandy Lean Clay															16.7	111.0	2.65		4.50		MC, Visual Class, Density, UC, QP
U-3	8.0-10.0	2.5Y 7/1 Light Gray Sandy Lean Clay															19.1	103.4	2.45		4.50		MC, Visual Class, Density, UC, QP
U-4	13.0-15.0	2.5Y 6/3 Light Olive Brown Lean Clay															27.5	91.9	1.63		3.75		MC, Visual Class, Density, UC, QP
U-5	18.0-20.0	10YR 5/4 Yellowish Brown Lean Sandy Clay															24.1	97.6	1.59		3.50		MC, Visual Class, Density, UC, QP
Run 1 Core	68.3-78.6	5Y Olive Gray 4/2 Andesite															10.3	102.1		720			Rock Core UC (ASTM D7012)

PIMCS Buckley SFB Soil Testing

Buckley SFB, Colorado

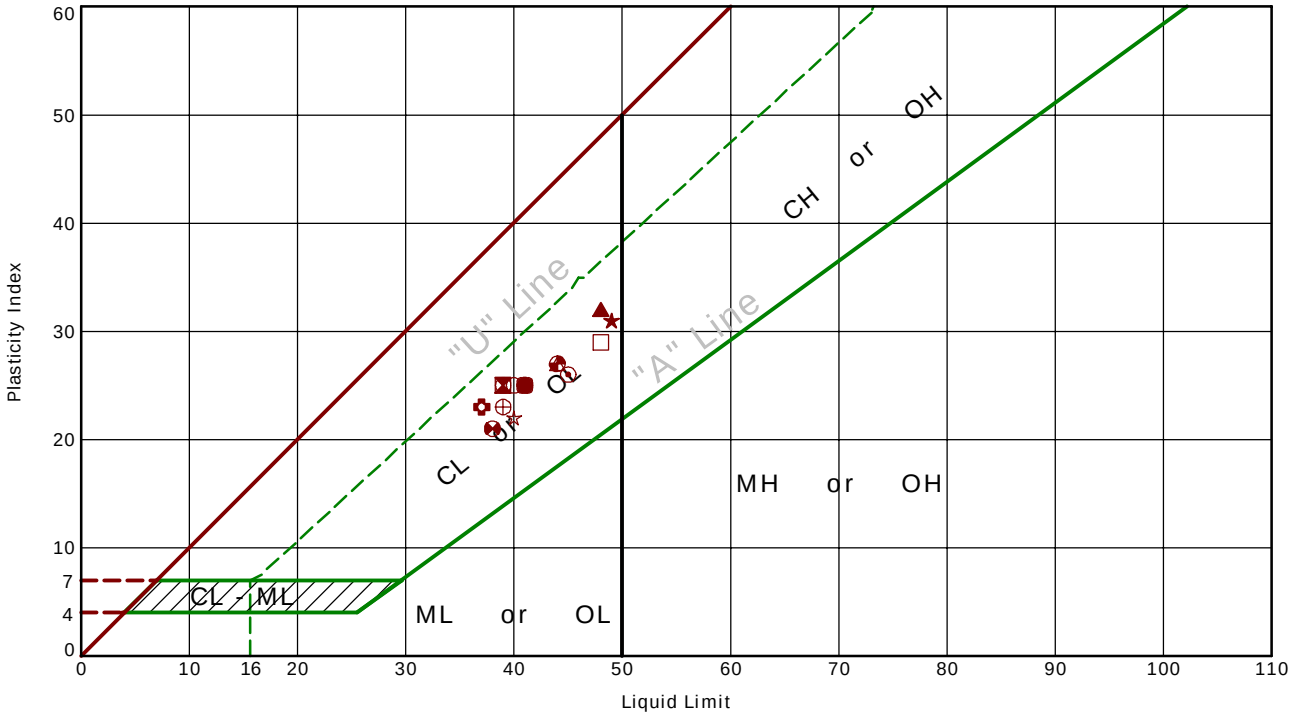
Terracon Project No. 05241404

Boring and Sample Nos.	Depth (ft)	Descriptions	USCS	Sieve % Passing										Atterberg			Moisture Content	Dry Density	UC Value	RC UC Value	Q.P.	Swell Method C	Required Tests
				1"	3/4"	1/2"	3/8"	#4	#10	#20	#40	#80	#200	LL	PL	PI	%	PCF	tsf	psi		%	
BU24-04 D-1	1.5-3.0	2.5Y 4/2 Dark Grayish Brown Lean Clay with Sand	CL				100.0	99.9	96.9	92.5	88.0	81.5	74.8	38	17	21	19.8						MC, Visual Class, AL, MA
D-2	3.0-4.5	2.5Y 5/4 Light Olive Brown Lean Clay															20.3						MC, Visual Class, Chem Testing
D-3	5.5-7.0	2.5Y 6/3 Light Yellowish Brown Lean Clay with Sand	CL					100.0	99.5	97.4	92.7	85.5	78.0	44	17	27	20.2						MC, Visual Class, AL, MA
D-4	8.5-10.0	2.5Y 6/3 Yellowish Brown Lean Clay															21.9						MC, Visual Class
D-5	13.5-15.0	2.5Y 5/2 Grayish Brown Sandy Lean Clay															12.3						MC, Visual Class
D-6	18.5-20.0	2.5Y 6/3 Light Yellowish Brown Lean Clay															18.5						MC, Visual Class
BU24-05 D-1	1.5-3.0	10YR 5/2 Grayish Brown Lean Clay															20.6						MC, Visual Class
D-2	3.0-4.5	10YR 7/2 Light Gray Lean Clay	CL					100.0	99.9	99.5	98.7	97.1	92.8	40	18	22	20.0						MC, Visual Class, AL, MA, Chem Testing
D-3	5.5-7.0	2.5Y 5/3 Light Olive Brown Sandy Lean Clay	CL					100.0	99.9	98.7	93.4	77.3	61.3	41	16	25	18.8						MC, Visual Class, AL, MA
D-4	8.5-10.0	2.5Y 5/6 Light Olive Brown Sandy Lean Clay															15.1						MC, Visual Class
D-5	13.5-15.0	2.5Y 5/6 Light Olive Brown Clayey Sand															13.8						MC, Visual Class
D-6	18.5-20.0	2.5Y 4/3 Olive Brown Clayey Sand															10.5						MC, Visual Class
BU24-06 D-1	1.5-3.0	10YR 6/4 Light Yellowish Brown Silty Lean Clay															9.0						MC, Visual Class
D-2	3.0-4.5	10YR 6/4 Light Yellowish Brown Silty Lean Clay															12.8						MC, Visual Class
D-3	5.5-7.0	10YR 6/4 Light Yellowish Brown Silty Lean Clay															12.3						MC, Visual Class
D-4	8.5-10.0	10YR 6/3 Pale Brown Lean Clay															9.7						MC, Visual Class
D-5	13.5-15.0	10YR 6/3 Pale Brown Poorly Graded Sand with Clay															7.6						MC, Visual Class
D-6	18.5-20.0	10TE 6/4 Light Yellowish Brown Lean Clay with Sand															12.0						MC, Visual Class
BU24-07 D-1	1.5-3.0	10YR 5/4 Yellowish Brown Silty Lean Clay															9.1						MC, Visual Class
D-2	3.0-4.5	10YR 5/2 Grayish Brown Silty Lean Clay															12.5						MC, Visual Class
D-3	5.5-7.0	10YR 5/2 Grayish Brown Lean Clay															12.9						MC, Visual Class
D-4	8.5-10.0	10YR 6/4 Light Yellowish Brown Silty Lean Clay															13.3						MC, Visual Class
D-5	13.5-15.0	10YR 6/4 Light Yellowish Brown Lean Clay with Sand															8.2						MC, Visual Class
D-6	18.5-20.0	10YR 8/4 Very Pale Brown Poorly Graded Sand with Clay															6.1						MC, Visual Class

15080 A Cir
Omaha, NE

Atterberg Limit Results

ASTM D4318

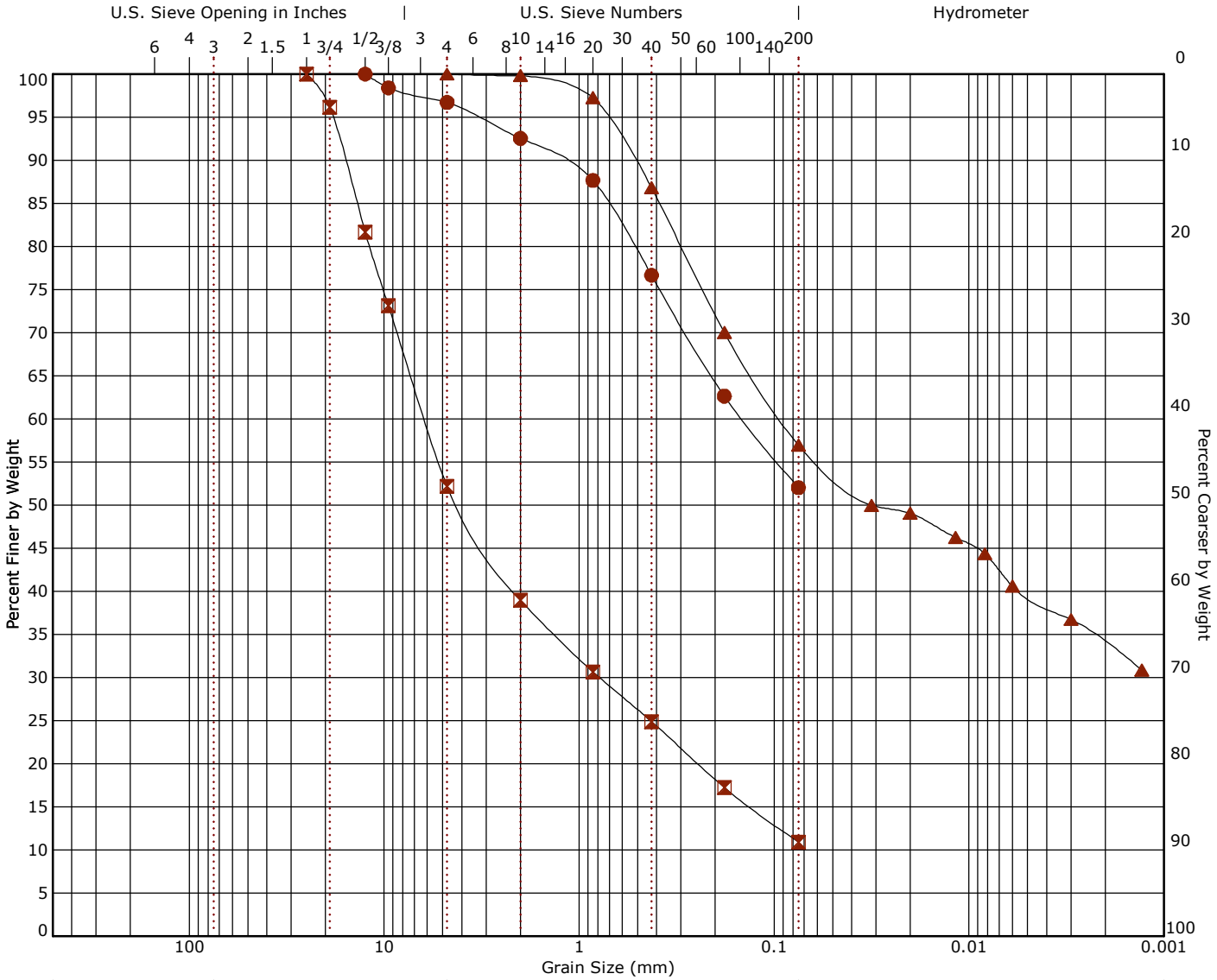


	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	BU24-01	1 - 2.5	41	16	25	52.0	CL	10YR 5/4 Yellowish Brown
⊠	BU24-01	5.5 - 7	39	14	25	57.0	CL	10YR 6/4 Light Yellowish Brown
▲	BU24-01	8.5 - 10	48	16	32		CL	10YR 6/4 Light Yellowish Brown
★	BU24-02	13.5 - 15	49	18	31		CL	10YR 6/6 Brownish Yellow
⊙	BU24-02	28.5 - 30	45	19	26		CL	2.5Y 6/3 Light Yellowish Brown
✿	BU24-02A	1 - 3	37	14	23	58.8	CL	10YR 5/6 Yellowish Brown
○	BU24-02A	3 - 5	40	15	25	62.1	CL	10YR 4/6 Dark Yellowish Brown
△	BU24-02A	5 - 7	44	17	27	60.2	CL	10YR 5/4 Yellowish Brown
⊗	BU24-03	5.5 - 7	39	14	25	57.7	CL	5YR 5/3 Reddish Brown
⊕	BU24-03	8.5 - 10	39	16	23	68.2	CL	10YR 7/2 Light Gray
□	BU24-03	23.5 - 25	48	19	29	65.0	CL	10YR 6/4 Light Yellowish Brown
⊛	BU24-04	1.5 - 3	38	17	21	74.8	CL	2.5Y 4/2 Dark Grayish Brown
◒	BU24-04	5.5 - 7	44	17	27	78.0	CL	2.5Y 6/3 Light Yellowish Brown
☆	BU24-05	3 - 4.5	40	18	22	92.8	CL	10YR 7/2 Light Gray
⊠	BU24-05	5.5 - 7	41	16	25	61.3	CL	2.5Y 5/3 Light Olive Brown

Terracon
15080 A Cir
Omaha, NE

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay	USCS
●	BU24-01	1 - 2.5	0.0	3.3	44.7	52.0			CL
⊠	BU24-01	3 - 4.5	0.0	47.8	41.2	10.9			GW-GM
▲	BU24-01	5.5 - 7	0.0	0.0	43.0		17.4	39.6	CL

	Description
●	10YR 5/4 Yellowish Brown
⊠	10YR 4/2 Dark Grayish Brown
▲	10YR 6/4 Light Yellowish Brown

Remarks
● Sandy Lean Clay
⊠ Well Graded Gravel with Silt and Sand
▲ Sandy Lean Clay

● Sieve	● % Finer	⊠ Sieve	⊠ % Finer	▲ Sieve	▲ % Finer
1/2"	100.0	1"	100.0	#4	100.0
3/8"	98.41	3/4"	96.17	#10	99.82
#4	96.72	1/2"	81.67	#20	97.29
#10	92.54	3/8"	73.13	#40	86.84
#20	87.67	#4	52.17	#80	70.02
#40	76.67	#10	38.95	#200	56.95
#80	62.65	#20	30.67		
#200	52.02	#40	24.89		
		#80	17.23		
		#200	10.93		

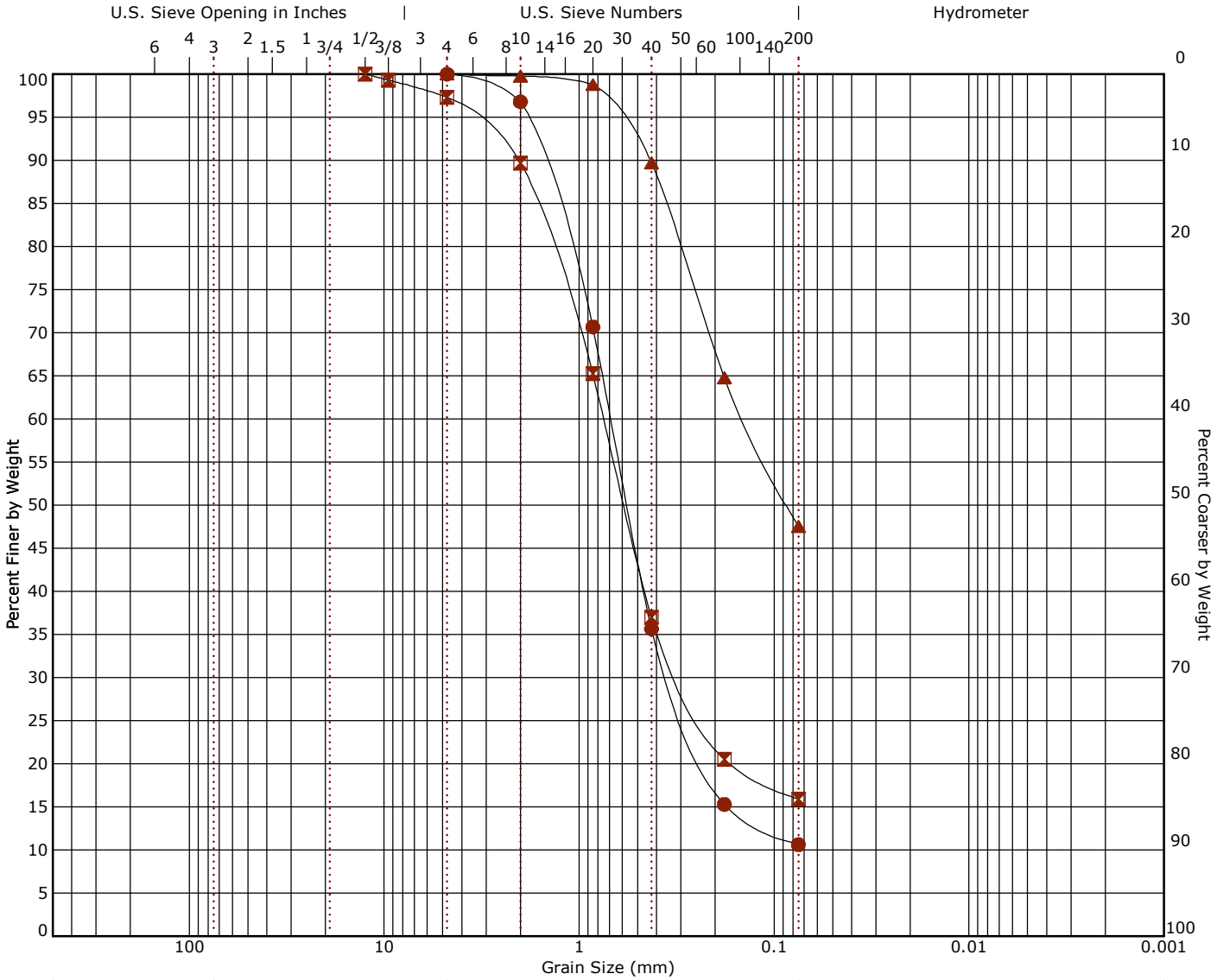
Grain Size	●	⊠	▲
D_{60}	0.145	6.154	0.092
D_{10}			

Coefficients	●	⊠	▲
C_c		1.52	
C_u		93.32	

15080 A Cir
Omaha, NE

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay	USCS
●	BU24-01	38.5 - 40	0.0	0.0	89.4	10.6			SW-SM
⊠	BU24-01	43.5 - 45	0.0	2.7	81.4	15.9			
▲	BU24-02	33.5 - 34	0.0	0.0	52.5	47.5			SC

	Description
●	2.5Y 6/4 Light Yellowish Brown
⊠	2.5Y 6/4 Light Yellowish Brown
▲	2.5Y 6/3 Light Yellowish Brown

	Remarks
●	Well Graded Sand with Silt
⊠	Clayey Sand
▲	Clayey Sand

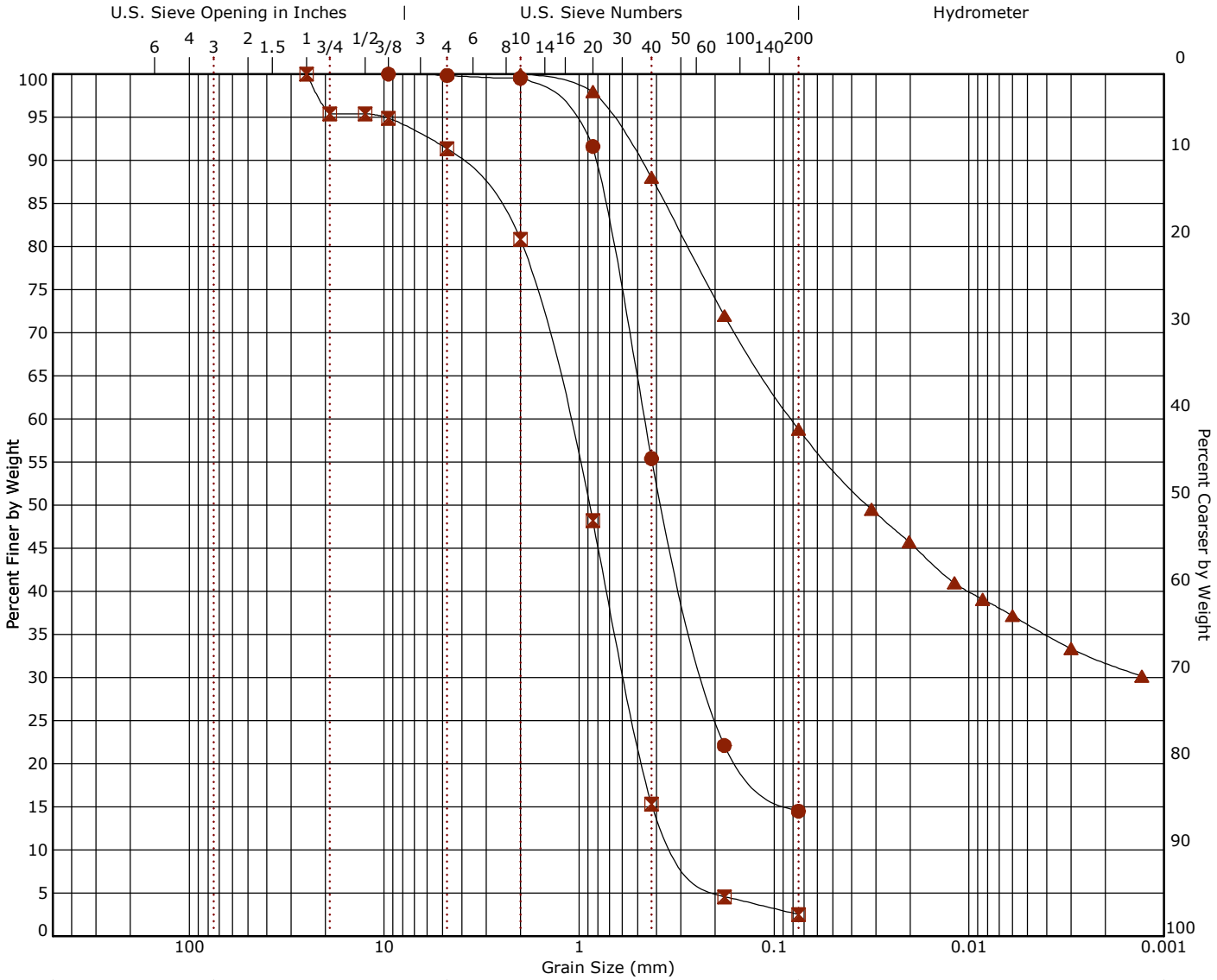
●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#4	100.0	1/2"	100.0	#4	100.0
#10	96.79	3/8"	99.31	#10	99.79
#20	70.66	#4	97.29	#20	98.78
#40	35.64	#10	89.71	#40	89.73
#80	15.28	#20	65.25	#80	64.76
#200	10.61	#40	37.02	#200	47.55
		#80	20.5		
		#200	15.89		

Grain Size	●	⊠	▲
D_{60}	0.688	0.747	0.141
D_{10}			

Coefficients	●	⊠	▲
C_c	2.44		
C_u	10.29		

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay	USCS
●	BU24-02	34 - 35	0.0	0.2	85.3	14.5			SM
⊠	BU24-02	43.5 - 45	0.0	8.7	88.8	2.5			SP
▲	BU24-02A	1 - 3	0.0	0.0	41.2		22.6	36.2	CL

Description	
●	10YR 6/3 Pale Brown
⊠	2.5Y 8/1 White
▲	10YR 5/6 Yellowish Brown

Remarks	
●	Silty Sand
⊠	Poorly Graded Sand
▲	Sandy Lean Clay

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
3/8"	100.0	1"	100.0	#10	100.0
#4	99.84	3/4"	95.38	#20	97.97
#10	99.53	1/2"	95.38	#40	88.01
#20	91.6	3/8"	94.89	#80	71.98
#40	55.4	#4	91.34	#200	58.78
#80	22.11	#10	80.81		
#200	14.5	#20	48.2		
		#40	15.35		
		#80	4.58		
		#200	2.51		

Grain Size	●	⊠	▲
D_{60}	0.464	1.158	0.081
D_{10}		0.277	

Coefficients	●	⊠	▲
C_c		1.04	
C_u		4.18	

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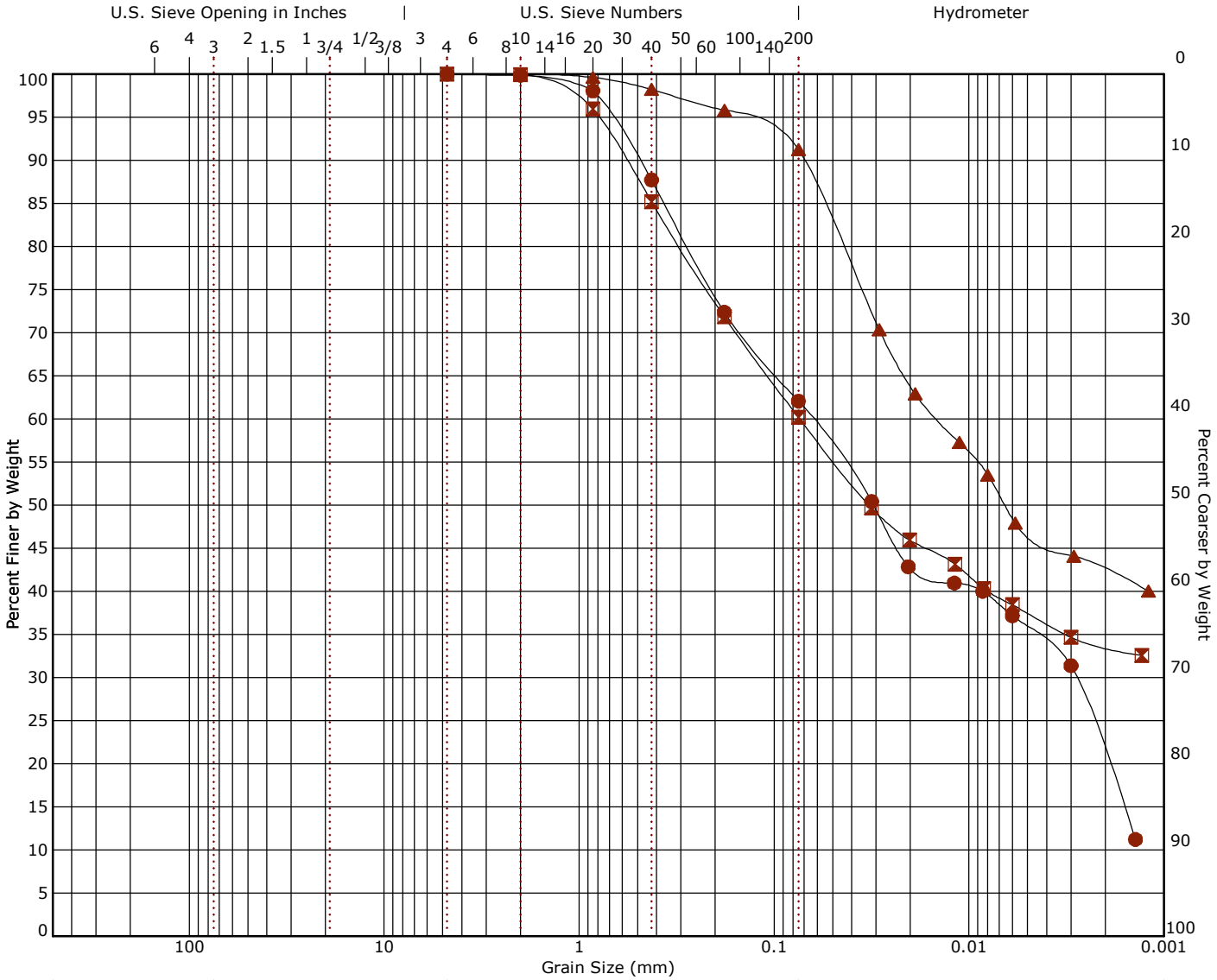
Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay	USCS
●	BU24-02A	3 - 5	0.0	0.0	37.9		26.4	35.6	CL
⊠	BU24-02A	5 - 7	0.0	0.0	39.8		22.7	37.4	CL
▲	BU24-03	1 - 2.5	0.0	0.0	8.7		44.2	47.1	CL

Description	
●	10YR 4/6 Dark Yellowish Brown
⊠	10YR 5/4 Yellowish Brown
▲	5YR 5/3 Reddish Brown

Remarks	
●	Sandy Lean Clay
⊠	Sandy Lean Clay
▲	Lean Clay

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#4	100.0	#4	100.0	#10	100.0
#10	99.88	#10	99.96	#20	99.62
#20	98.05	#20	95.96	#40	98.22
#40	87.72	#40	85.2	#80	95.82
#80	72.38	#80	71.83	#200	91.26
#200	62.06	#200	60.18		

Grain Size	●	⊠	▲
D_{60}	0.064	0.074	0.014
D_{10}			

Coefficients	●	⊠	▲
C_c			
C_u			

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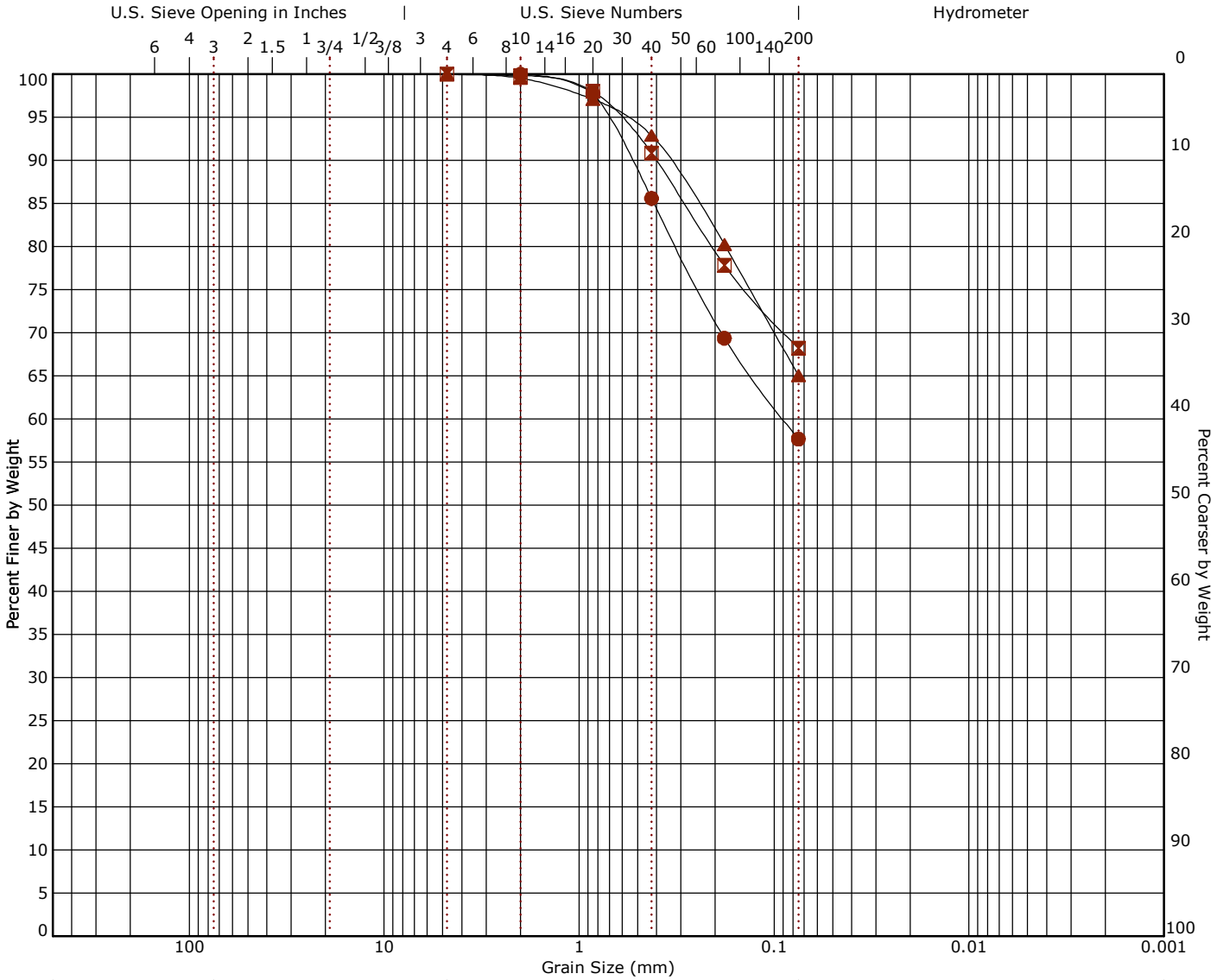
Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay	USCS
●	BU24-03	5.5 - 7	0.0	0.0	42.3	57.7			CL
⊠	BU24-03	8.5 - 10	0.0	0.0	31.8	68.2			CL
▲	BU24-03	23.5 - 25	0.0	0.0	35.0	65.0			CL

Description	
●	5YR 5/3 Reddish Brown
⊠	10YR 7/2 Light Gray
▲	10YR 6/4 Light Yellowish Brown

Remarks	
●	Sandy Lean Clay
⊠	Sandy Lean Clay
▲	Sandy Lean Clay

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#10	100.0	#4	100.0	#4	100.0
#20	97.78	#10	99.81	#10	99.54
#40	85.59	#20	97.99	#20	97.08
#80	69.36	#40	90.85	#40	92.88
#200	57.67	#80	77.82	#80	80.23
		#200	68.23	#200	65.02

Grain Size	●	⊠	▲
D_{60}	0.089		
D_{10}			

Coefficients	●	⊠	▲
C_c			
C_u			

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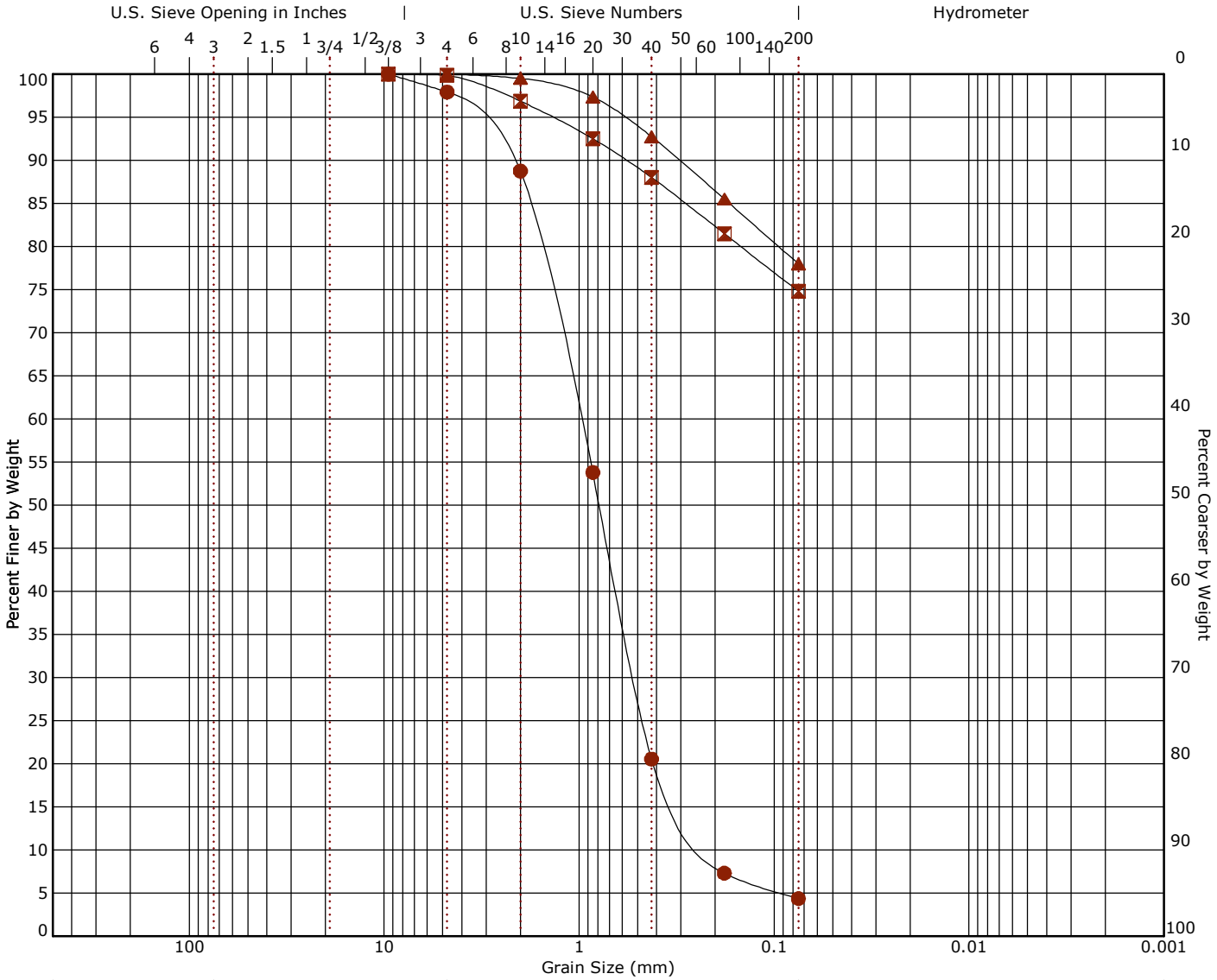
Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay	USCS
●	BU24-03	38.5 - 40	0.0	2.1	93.6	4.4			SP
⊠	BU24-04	1.5 - 3	0.0	0.1	25.1	74.8			CL
▲	BU24-04	5.5 - 7	0.0	0.0	22.0	78.0			CL

Description	
●	10YR 6/3 Pale Brown
⊠	2.5Y 4/2 Dark Grayish Brown
▲	2.5Y 6/3 Light Yellowish Brown

Remarks	
●	Poorly Graded Sand
⊠	Lean Clay with Sand
▲	Lean Clay with Sand

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
3/8"	100.0	3/8"	100.0	#4	100.0
#4	97.91	#4	99.86	#10	99.49
#10	88.76	#10	96.87	#20	97.36
#20	53.79	#20	92.51	#40	92.74
#40	20.54	#40	88.01	#80	85.52
#80	7.3	#80	81.49	#200	77.99
#200	4.36	#200	74.8		

Grain Size	●	⊠	▲
D_{60}	0.989		
D_{10}	0.214		

Coefficients	●	⊠	▲
C_c	1.26		
C_u	4.61		

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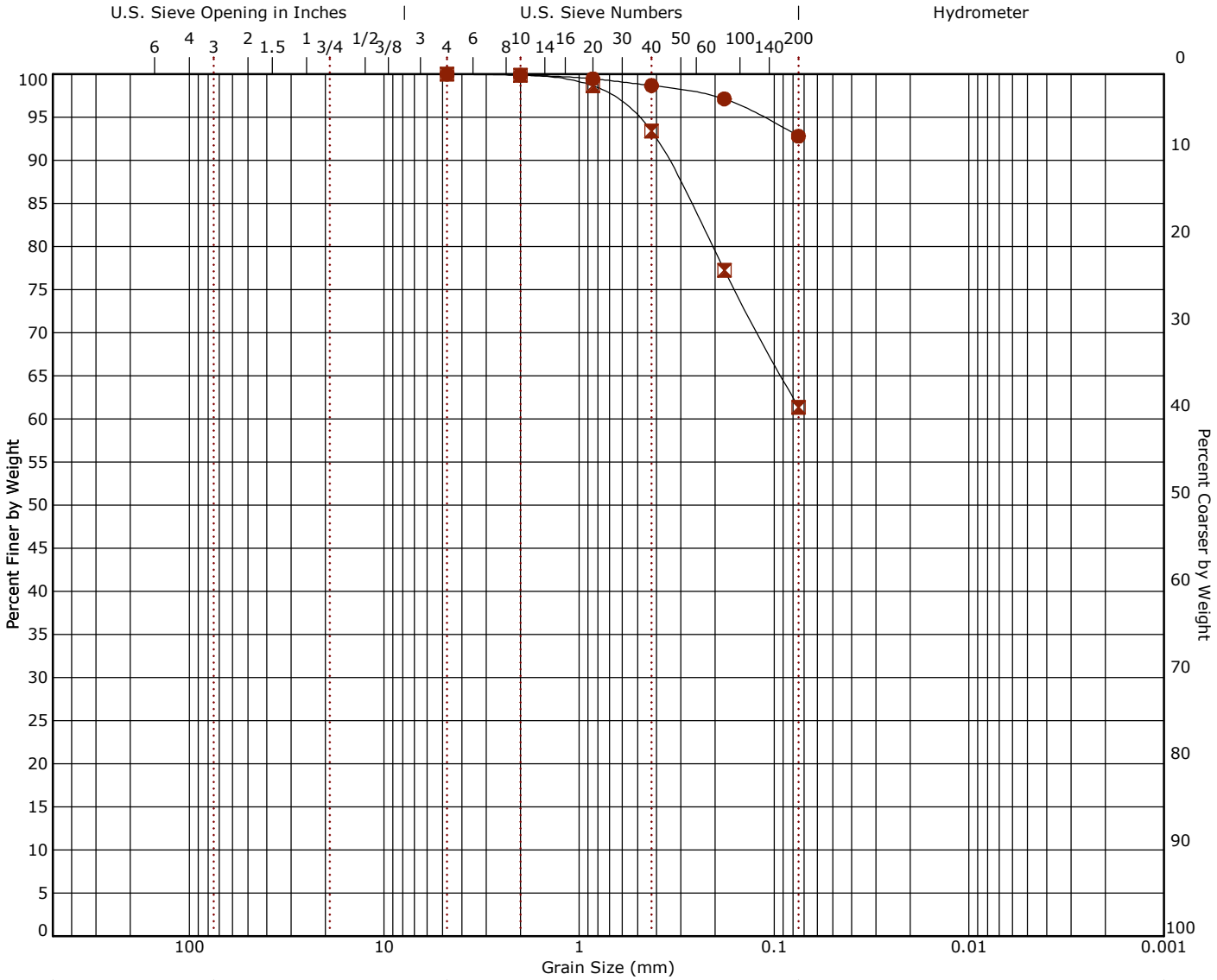
Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay	USCS
●	BU24-05	3 - 4.5	0.0	0.0	7.2	92.8			CL
⊠	BU24-05	5.5 - 7	0.0	0.0	38.7	61.3			CL

	Description
●	10YR 7/2 Light Gray
⊠	2.5Y 5/3 Light Olive Brown

	Remarks
●	Lean Clay
⊠	Sandy Lean Clay

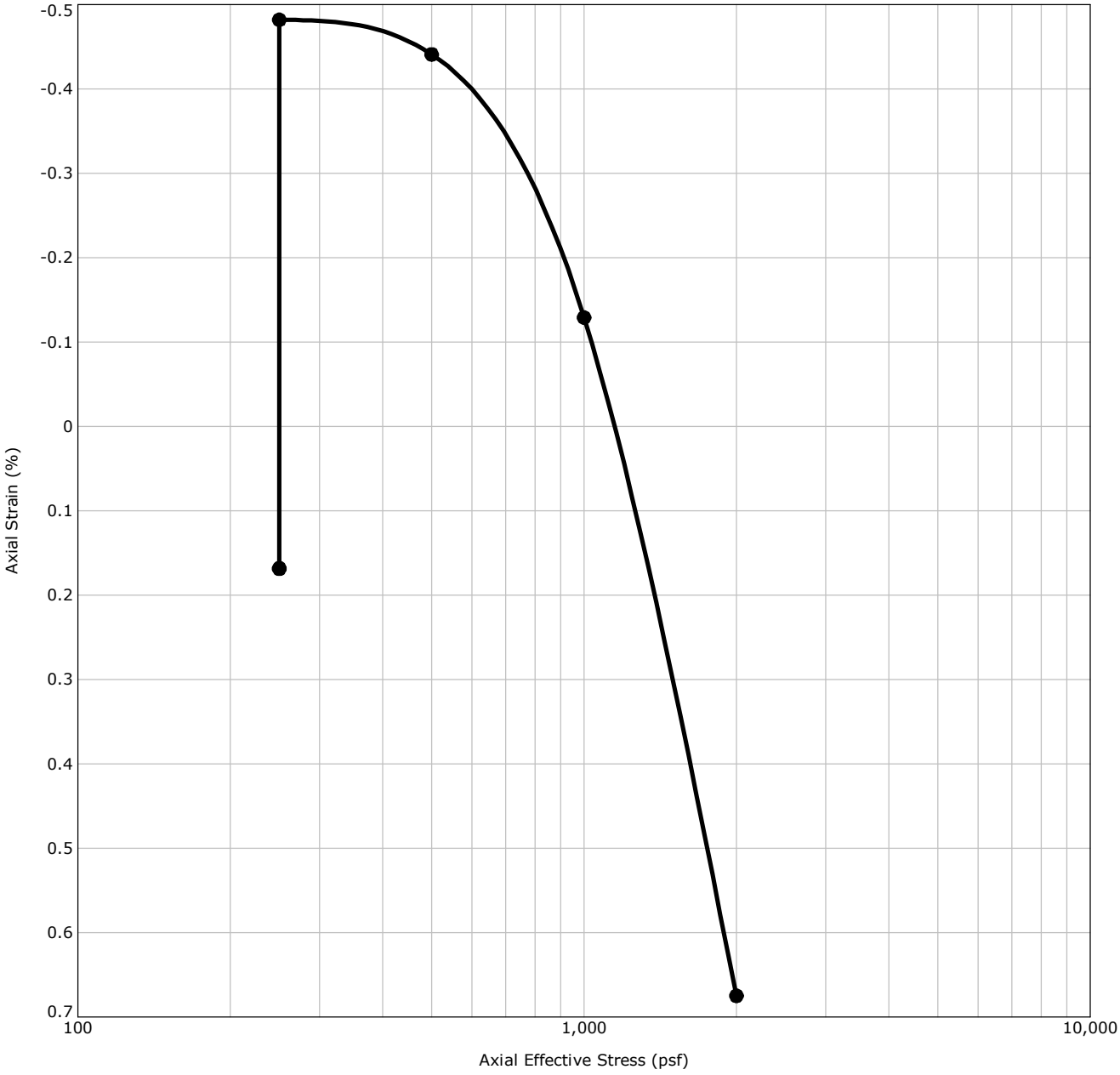
●		⊠			
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#4	100.0	#4	100.0		
#10	99.87	#10	99.9		
#20	99.45	#20	98.66		
#40	98.67	#40	93.38		
#80	97.12	#80	77.25		
#200	92.79	#200	61.34		

Grain Size			
	●	⊠	
D_{60}			
D_{10}			

Coefficients			
	●	⊠	
C_c			
C_u			

One-Dimensional Consolidation Test

D4546



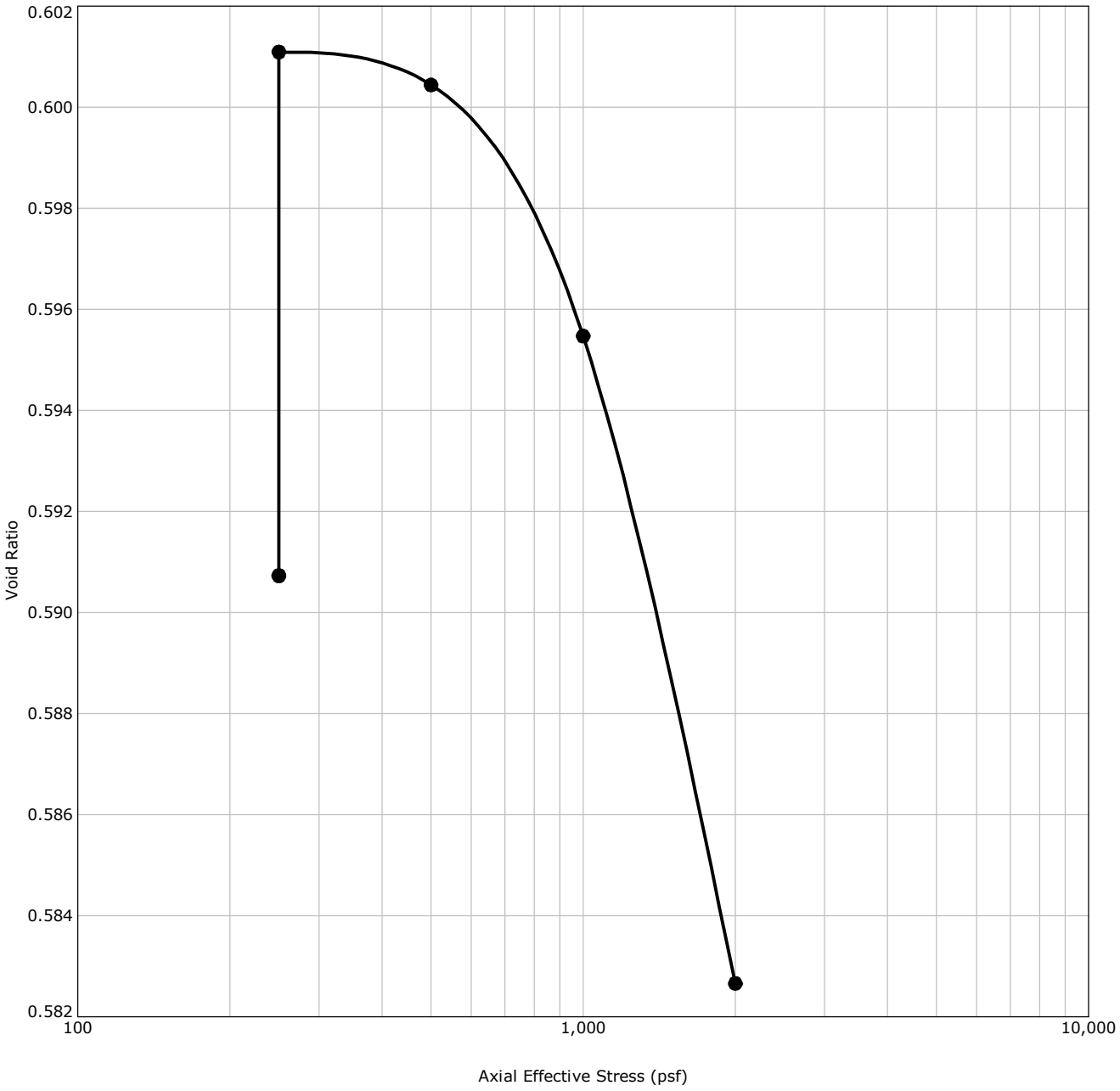
Boring ID	Depth (Ft)	Specimen #	Material Description	USCS	AASHTO
BU24-02A	1 - 3	U-1	10YR 5/6 Yellowish Brown	CL	A-6

Natural		Initial Dry Density (pcf)	LL	PI	Specific Gravity	Overburden (psf)	P_c (psf)	C_c (% / log stress)	C_r (% / log stress)	Initial Void Ratio
Saturation (%)	Moisture (%)									
84.5	18.6	105.8	37	23	2.70	120				

Notes: Swell %: 0.651
Specific gravity is assumed.
Test specimen cut from indicated sample; dry density and moisture content may vary from boring log.
Initial Diameter: 2.5 inches
Initial Height: 1 inch

One-Dimensional Consolidation Test

D4546



Boring ID	Depth (Ft)	Specimen #	Material Description	USCS	AASHTO
BU24-02A	1 - 3	U-1	10YR 5/6 Yellowish Brown	CL	A-6

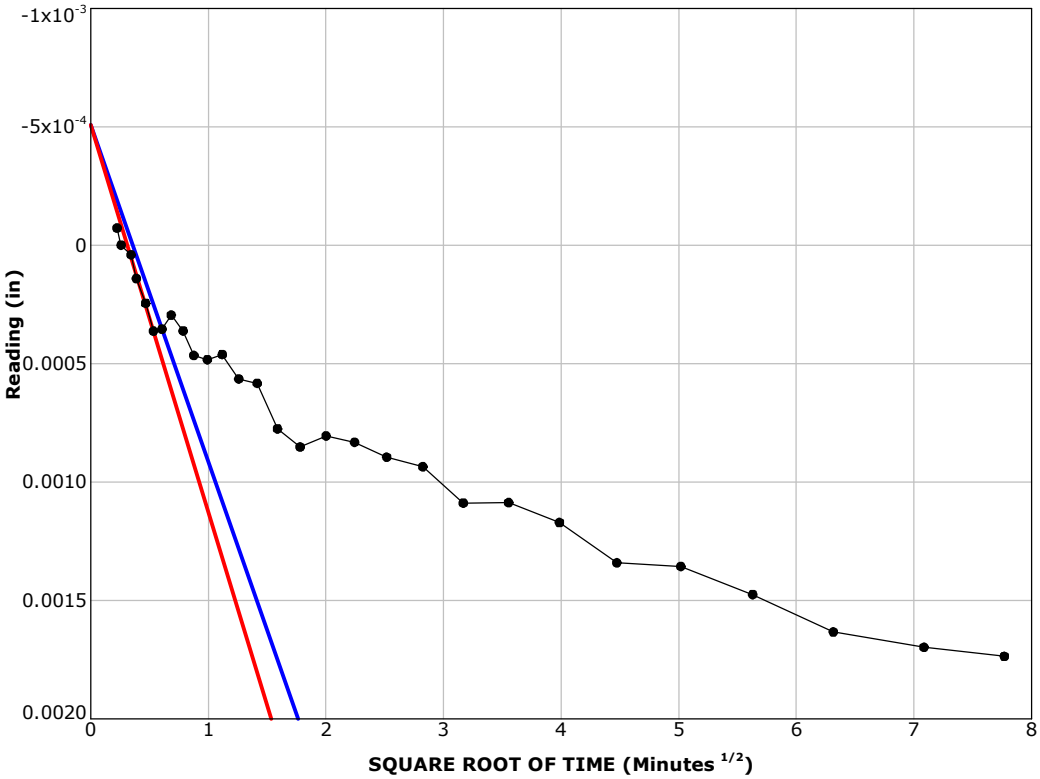
Natural		Initial Dry Density (pcf)	LL	PI	Specific Gravity	Overburden (psf)	P_c (psf)	C_c (vr / log stress)	C_r (vr / log stress)	Initial Void Ratio
Saturation (%)	Moisture (%)									
84.5	18.6	105.8	37	23	2.70	120				

Notes: Swell %: 0.651
Specific gravity is assumed.
Test specimen cut from indicated sample; dry density and moisture content may vary from boring log.
Initial Diameter: 2.5 inches
Initial Height: 1 inch

Time Deformation Curve

D4546

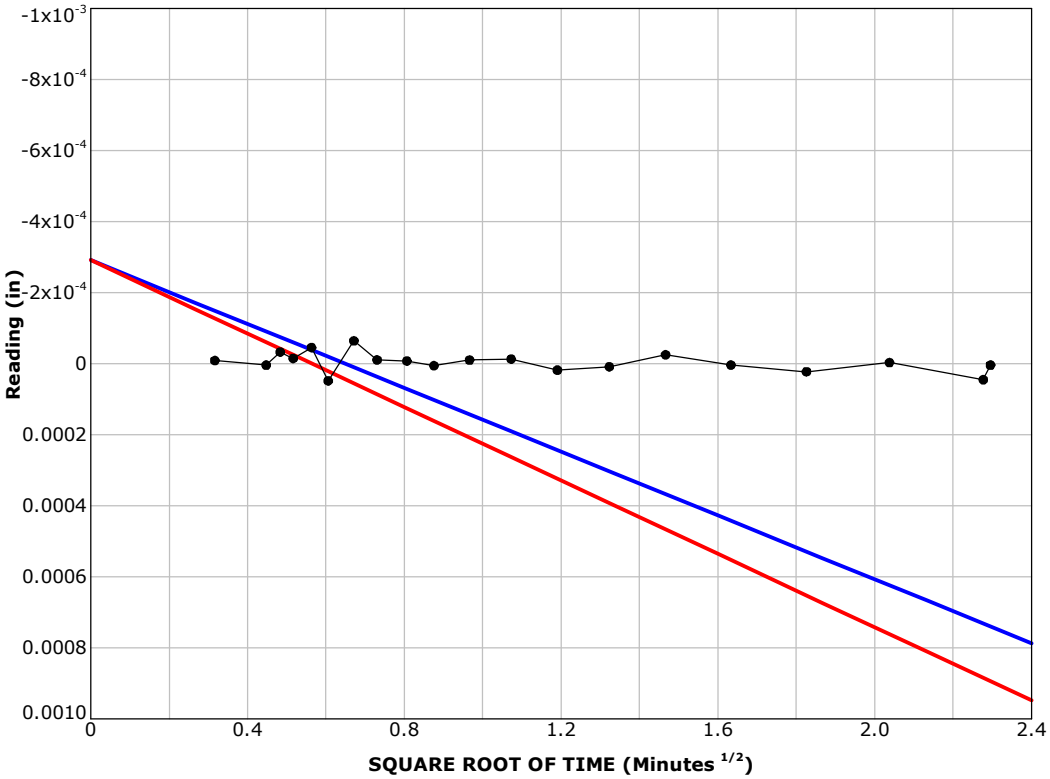
Borehole: BU24-02A Depth: 1 Specimen #: U-1



Load No. = 1

Load = 250 psf

Borehole: BU24-02A Depth: 1 Specimen #: U-1



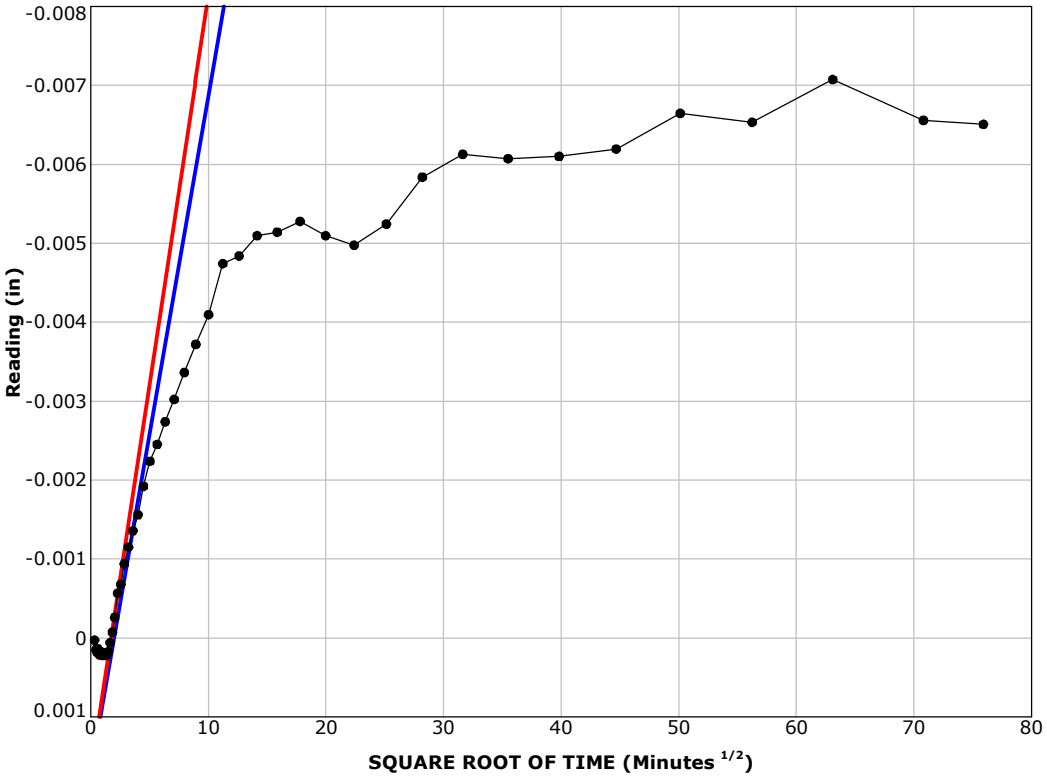
Load No. = 2

Load = 250 psf

Time Deformation Curve

D4546

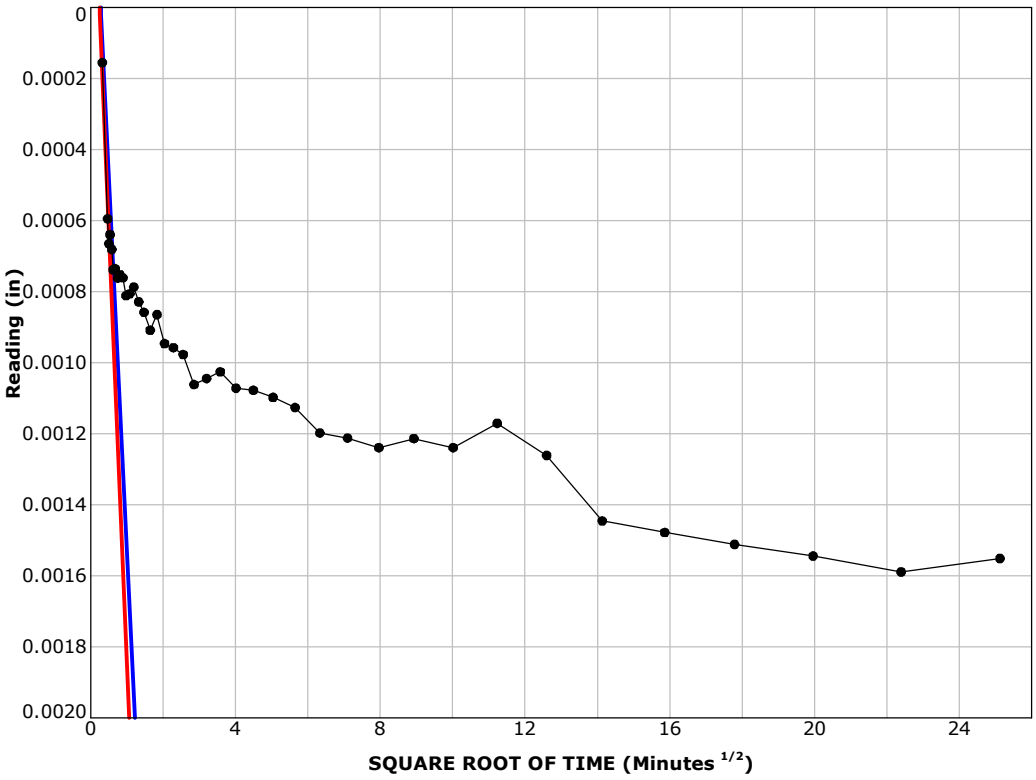
Borehole: BU24-02A Depth: 1 Specimen #: U-1



Load No. = 3

Load = 250 psf

Borehole: BU24-02A Depth: 1 Specimen #: U-1



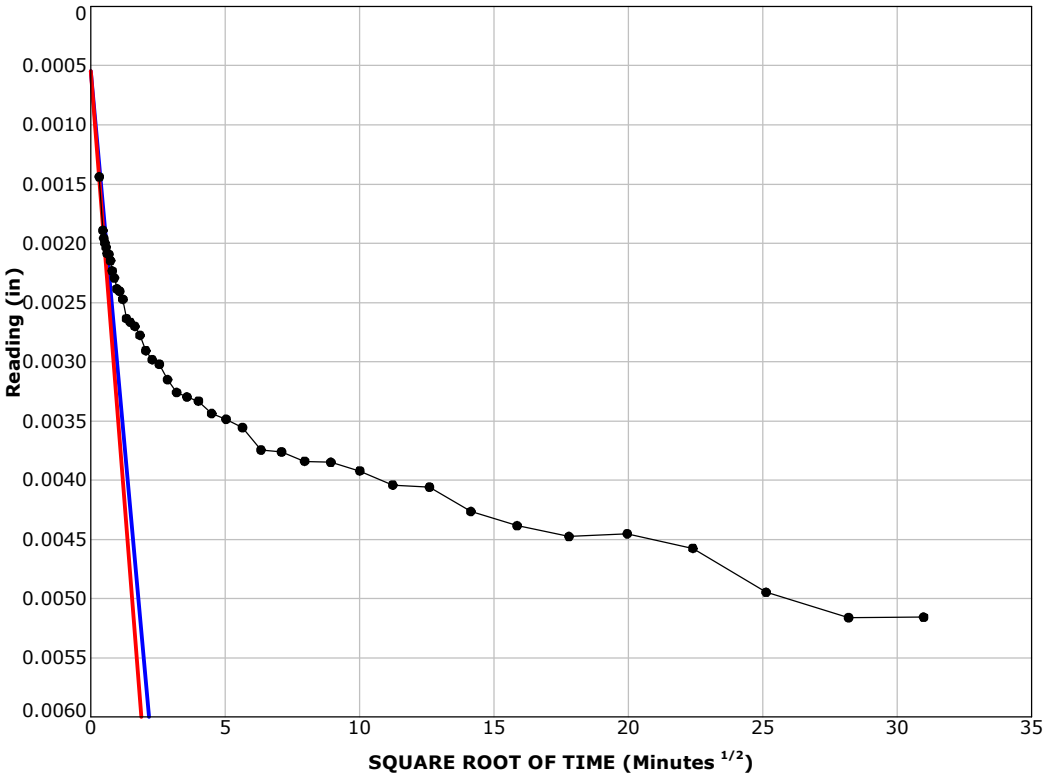
Load No. = 4

Load = 500 psf

Time Deformation Curve

D4546

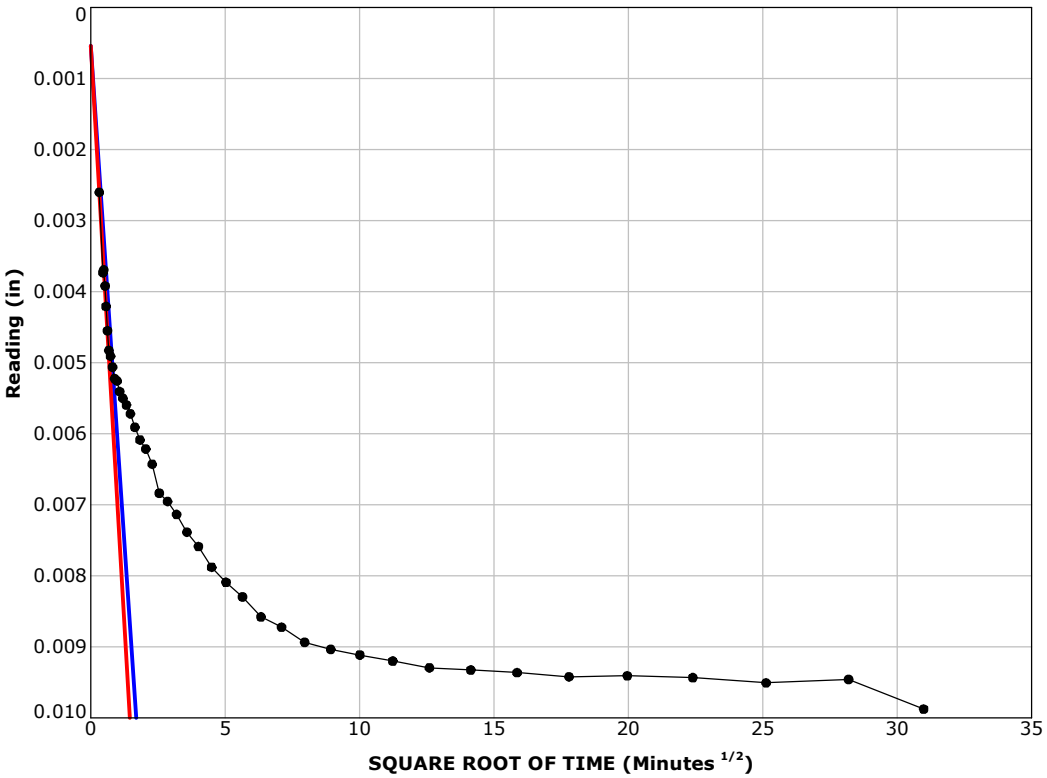
Borehole: BU24-02A Depth: 1 Specimen #: U-1



Load No. = 5

Load = 1000 psf

Borehole: BU24-02A Depth: 1 Specimen #: U-1



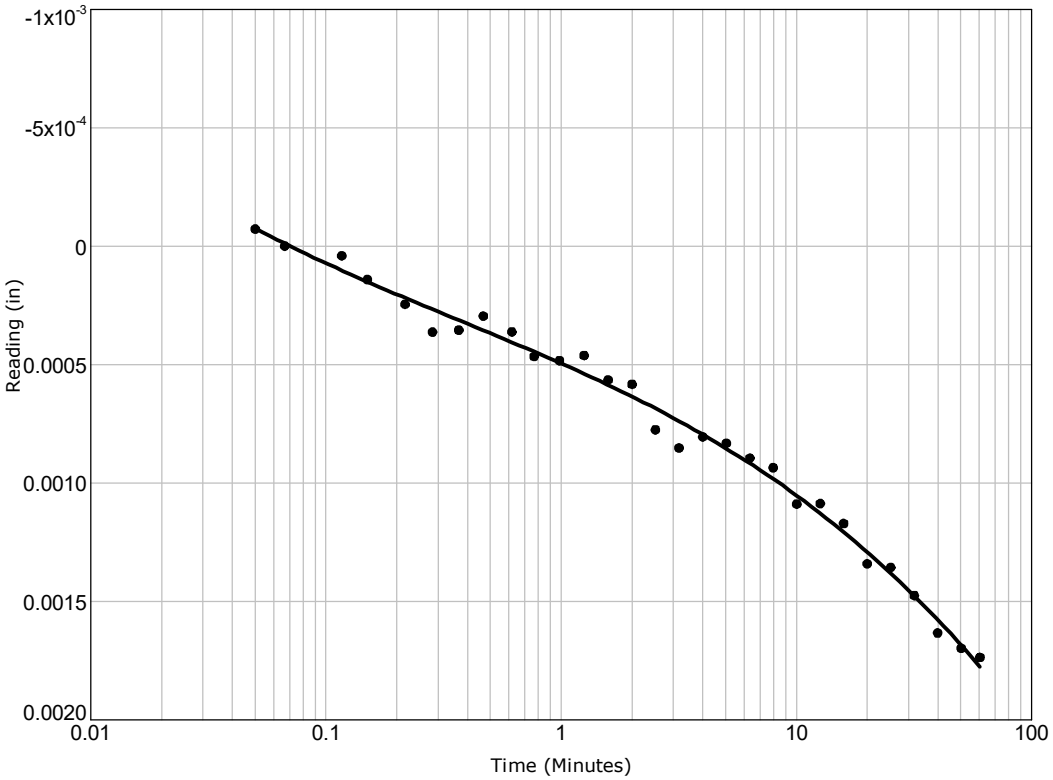
Load No. = 6

Load = 2000 psf

Time Deformation Curve

D4546

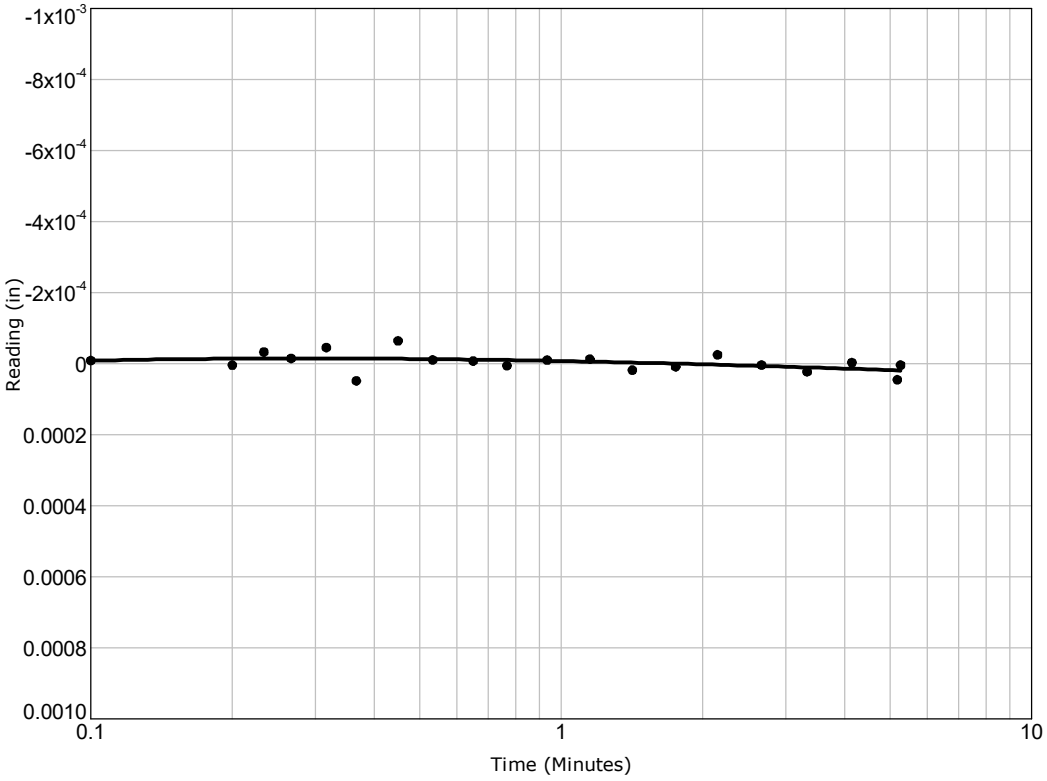
Borehole: BU24-02A Depth: 1 Specimen #: U-1



Load No. = 1

Load = 250 psf

Borehole: BU24-02A Depth: 1 Specimen #: U-1



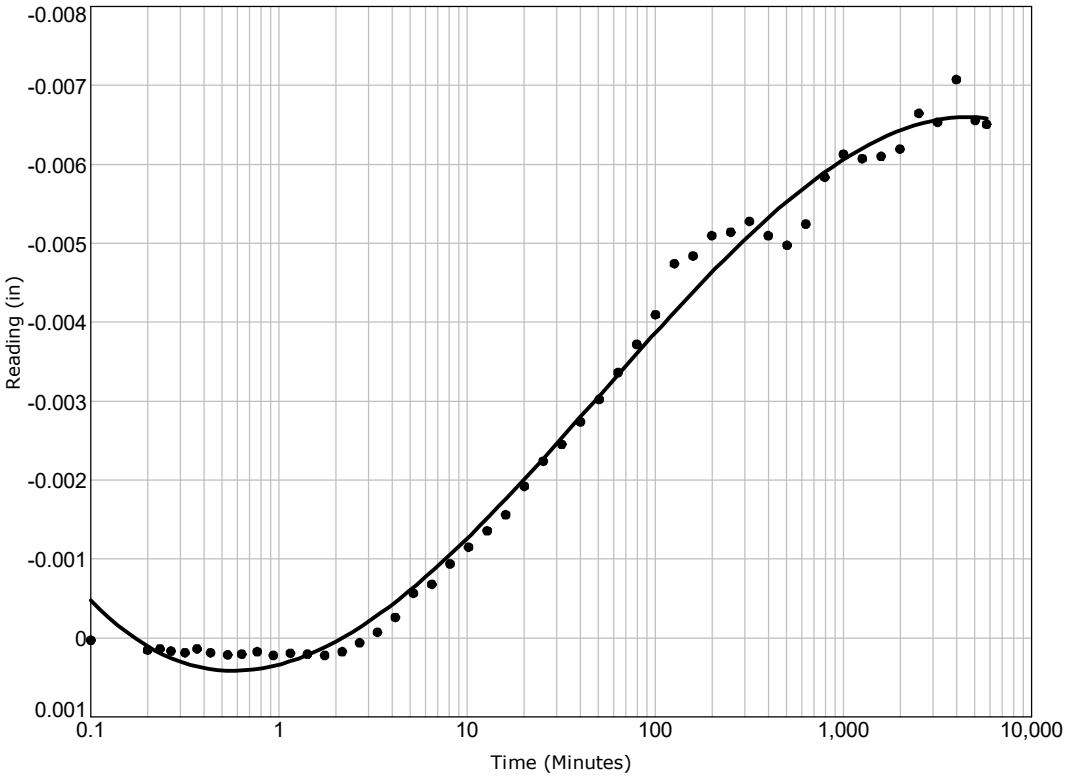
Load No. = 2

Load = 250 psf

Time Deformation Curve

D4546

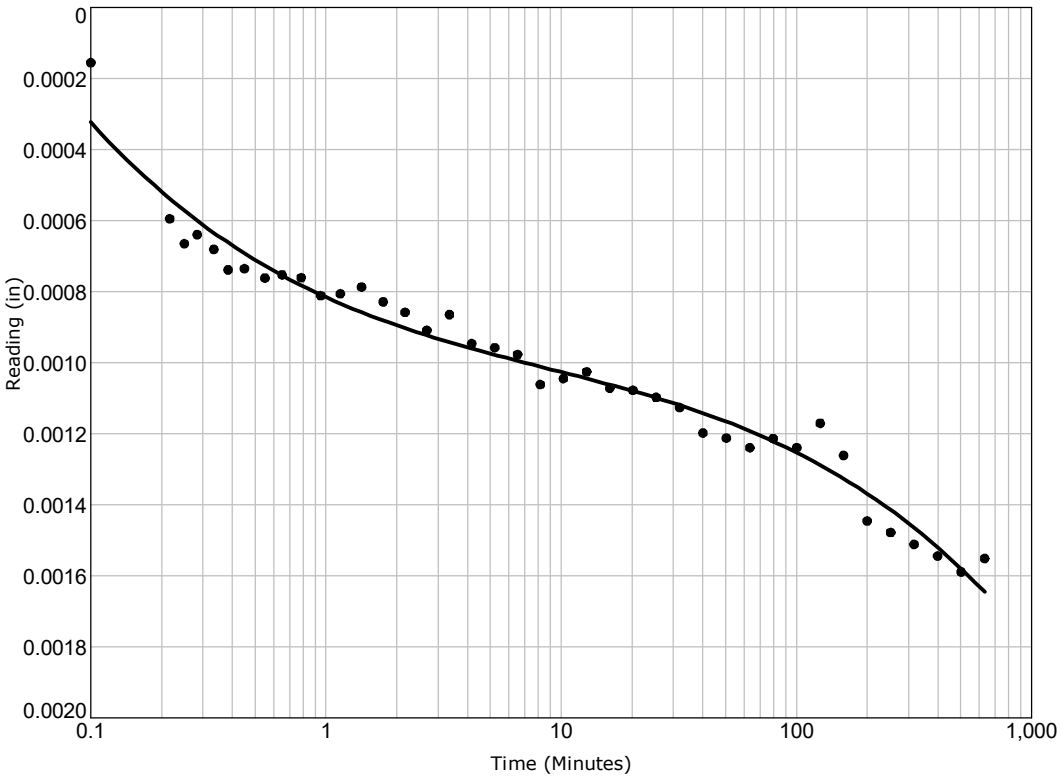
Borehole: BU24-02A Depth: 1 Specimen #: U-1



Load No. = 3

Load = 250 psf

Borehole: BU24-02A Depth: 1 Specimen #: U-1



Load No. = 4

Load = 500 psf

15080 A Cir
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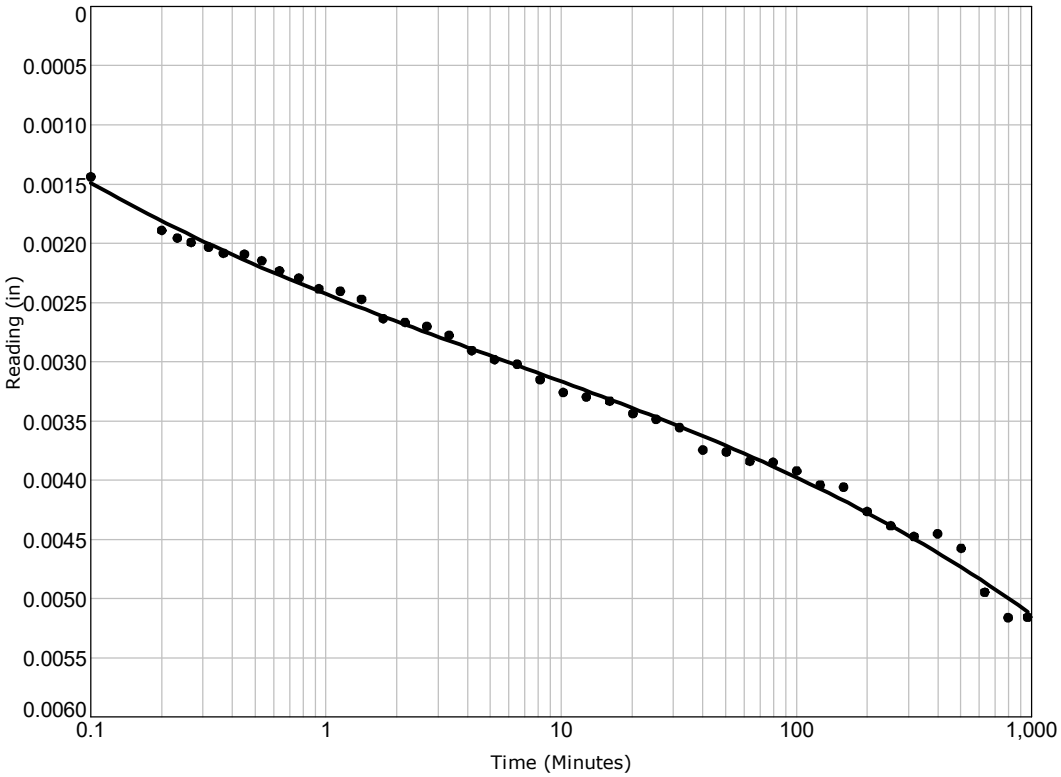
Time Deformation Curve

D4546

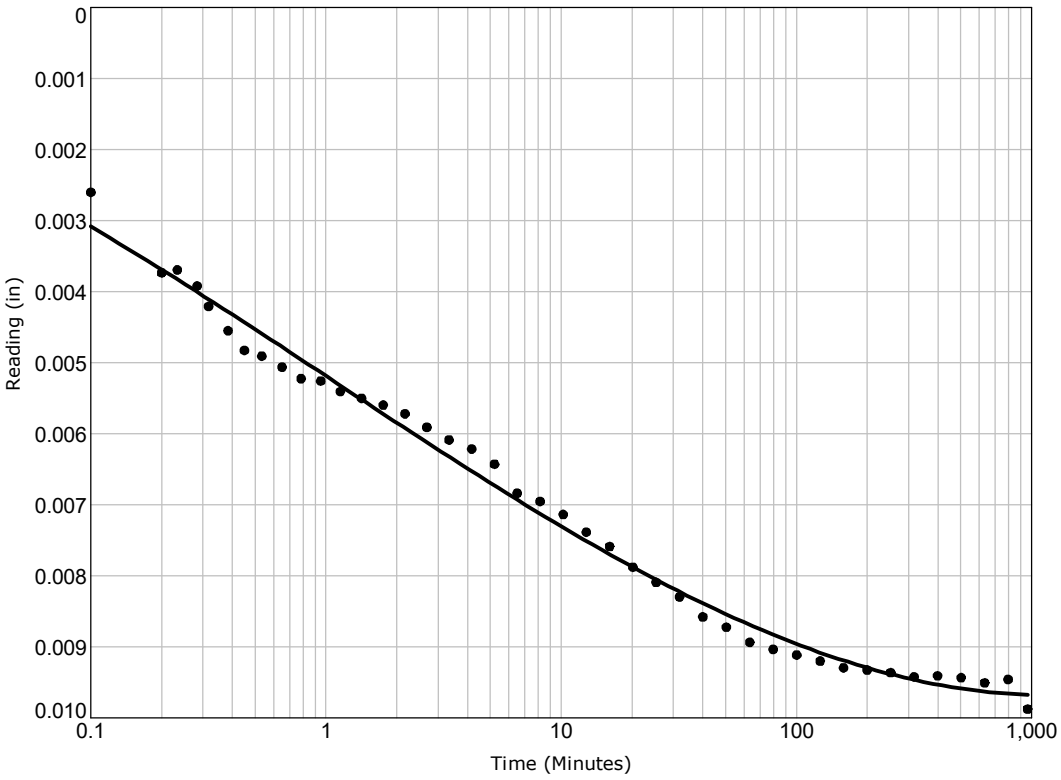
Borehole: BU24-02A Depth: 1 Specimen #: U-1



Load No. = 5

Load = 1000 psf

Borehole: BU24-02A Depth: 1 Specimen #: U-1

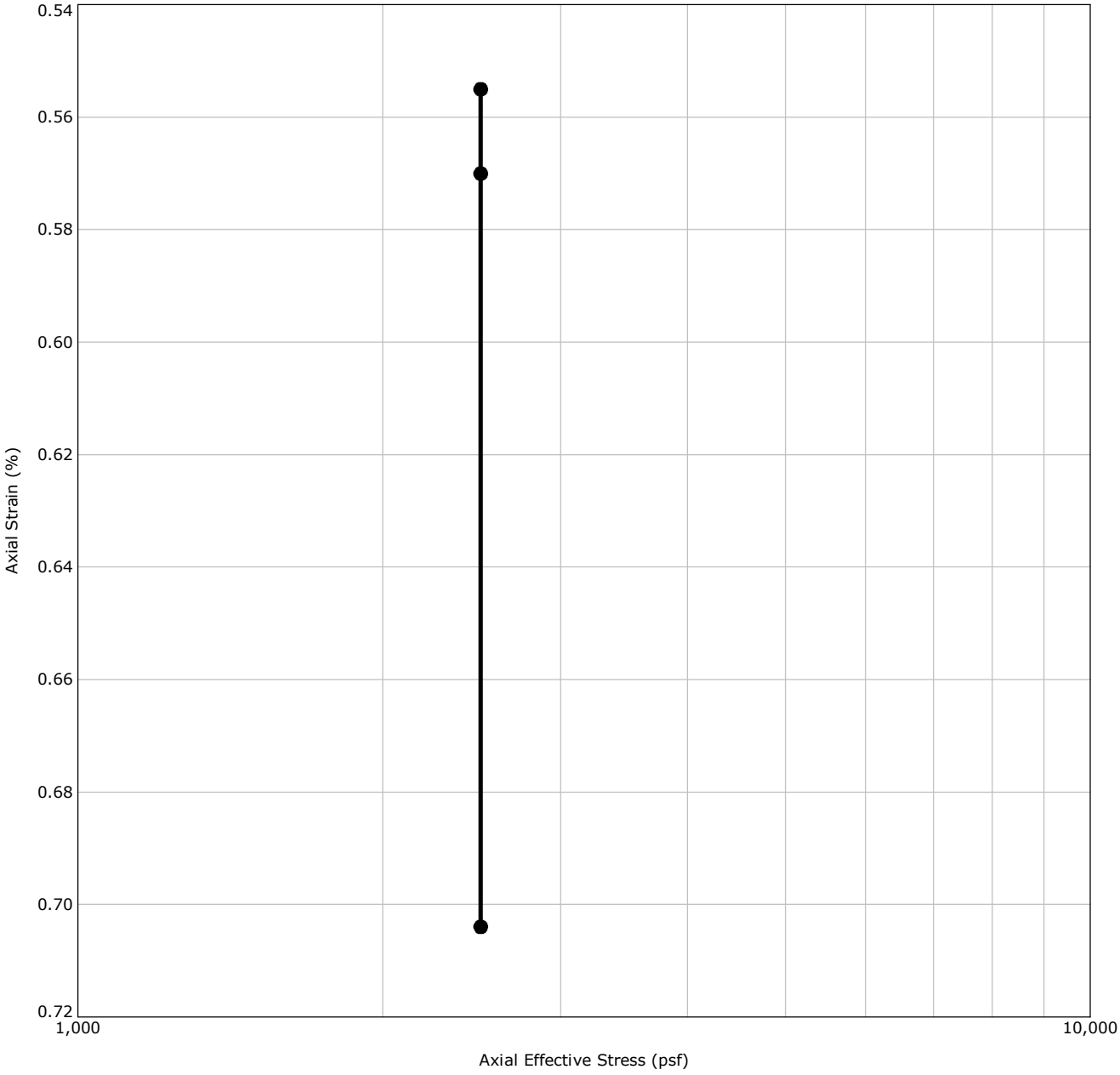


Load No. = 6

Load = 2000 psf

One-Dimensional Consolidation Test

D4546



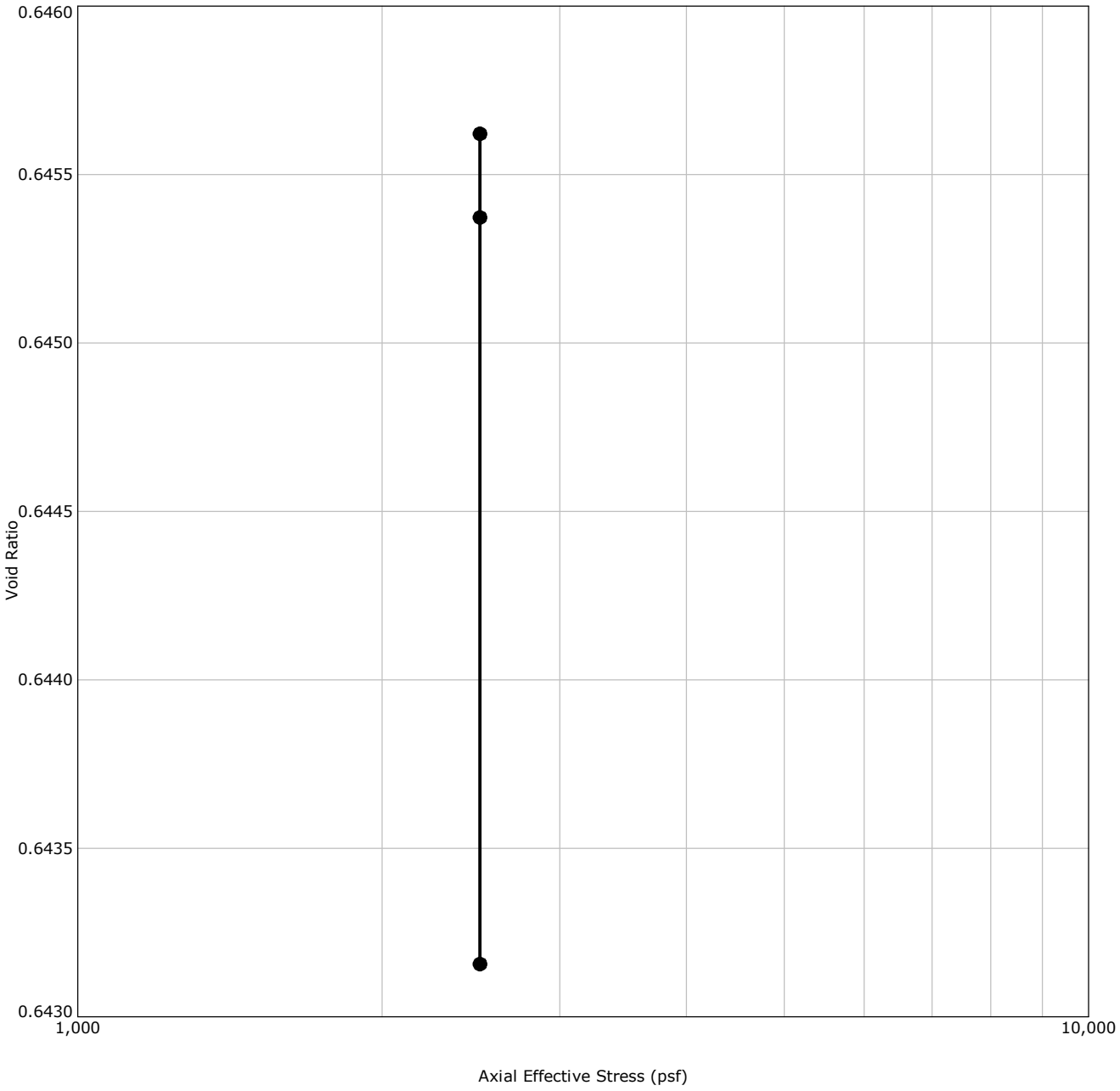
Boring ID	Depth (Ft)	Specimen #	Material Description	USCS	AASHTO
BU24-02A	3 - 5	U-2	10YR 4/6 Dark Yellowish Brown	CL	A-6

Natural		Initial Dry Density (pcf)	LL	PI	Specific Gravity	Overburden (psf)	P_c (psf)	C_c (% / log stress)	C_r (% / log stress)	Initial Void Ratio
Saturation (%)	Moisture (%)									
82.3	19.9	101.9	40	25	2.70	360				

Notes: Collapse %: 0.134
Specific gravity is assumed.
Test specimen cut from indicated sample; dry density and moisture content may vary from boring log.
Initial Diameter: 2.5 inches
Initial Height: 1 inch

One-Dimensional Consolidation Test

D4546



Boring ID	Depth (Ft)	Specimen #	Material Description	USCS	AASHTO
BU24-02A	3 - 5	U-2	10YR 4/6 Dark Yellowish Brown	CL	A-6

Natural		Initial Dry Density (pcf)	LL	PI	Specific Gravity	Overburden (psf)	P_c (psf)	C_c (vr / log stress)	C_r (vr / log stress)	Initial Void Ratio
Saturation (%)	Moisture (%)									
82.3	19.9	101.9	40	25	2.70	360				

Notes: Collapse %: 0.134
Specific gravity is assumed.
Test specimen cut from indicated sample; dry density and moisture content may vary from boring log.
Initial Diameter: 2.5 inches
Initial Height: 1 inch

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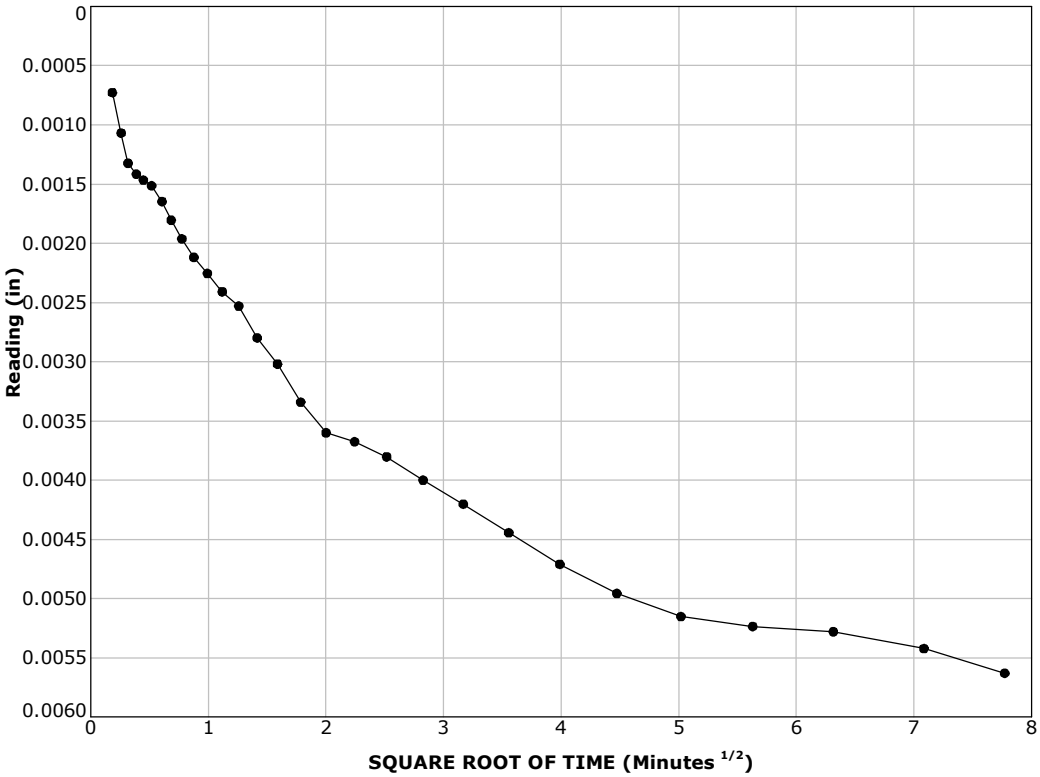
Time Deformation Curve

D4546

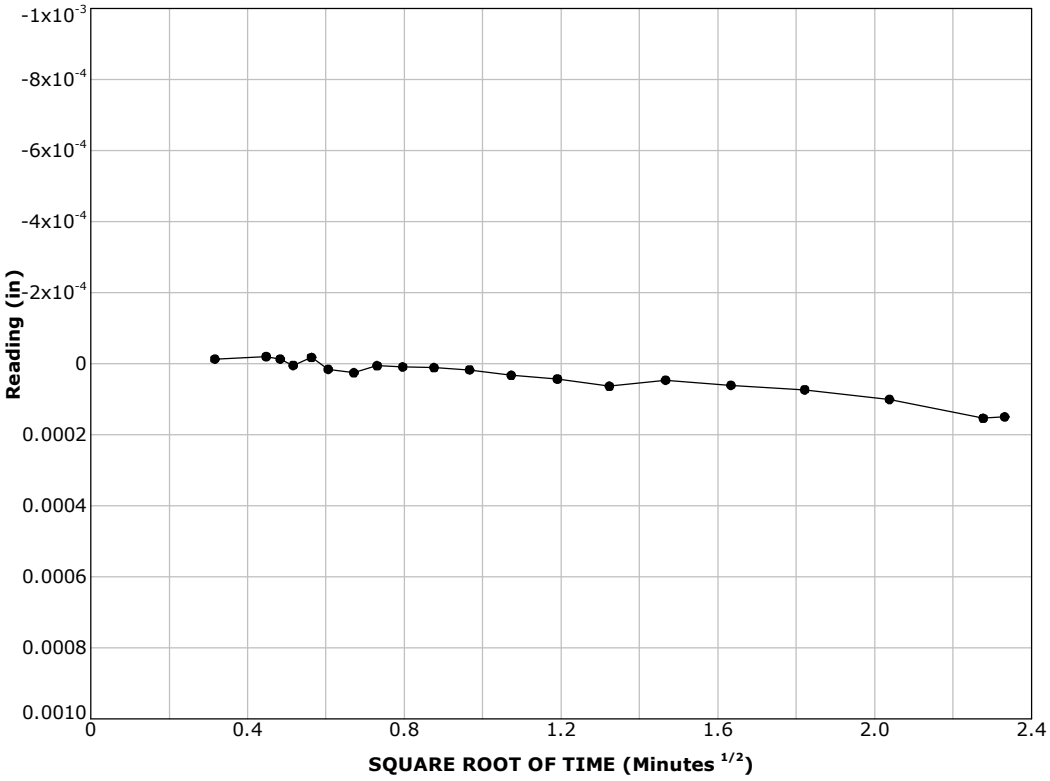
Borehole: BU24-02A Depth: 3 Specimen #: U-2



Load No. = 1

Load = 2500 psf

Borehole: BU24-02A Depth: 3 Specimen #: U-2



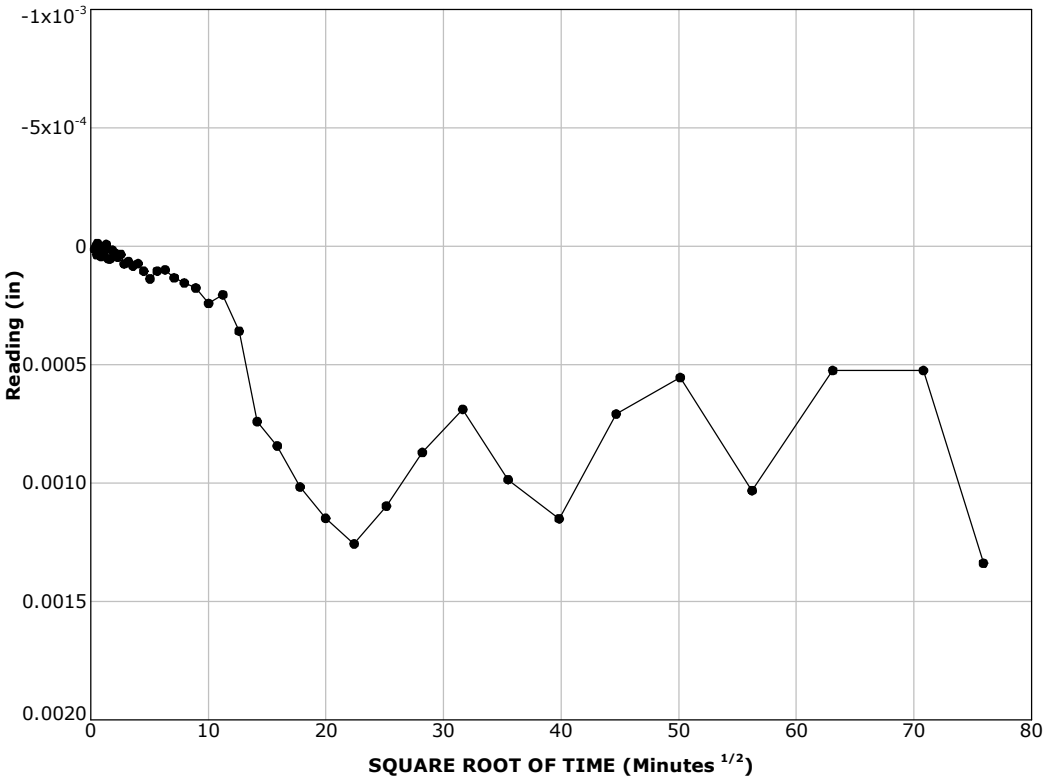
Load No. = 2

Load = 2500 psf

Time Deformation Curve

D4546

Borehole: BU24-02A Depth: 3 Specimen #: U-2



Load No. = 3

Load = 2500 psf

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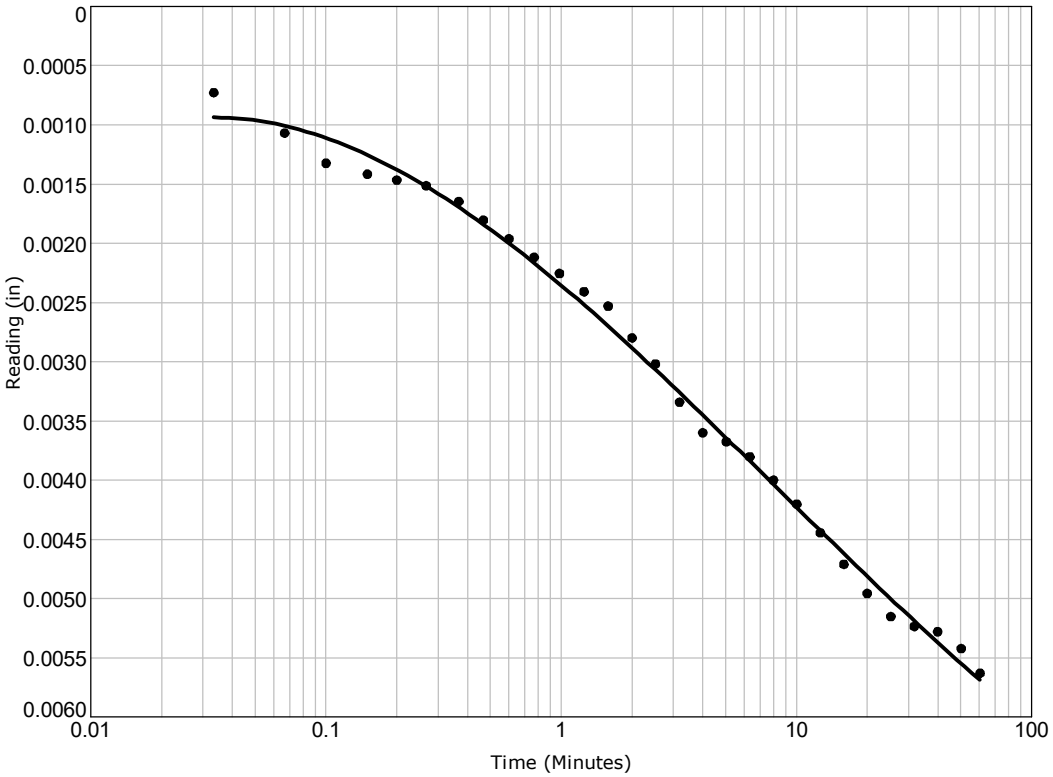
Time Deformation Curve

D4546

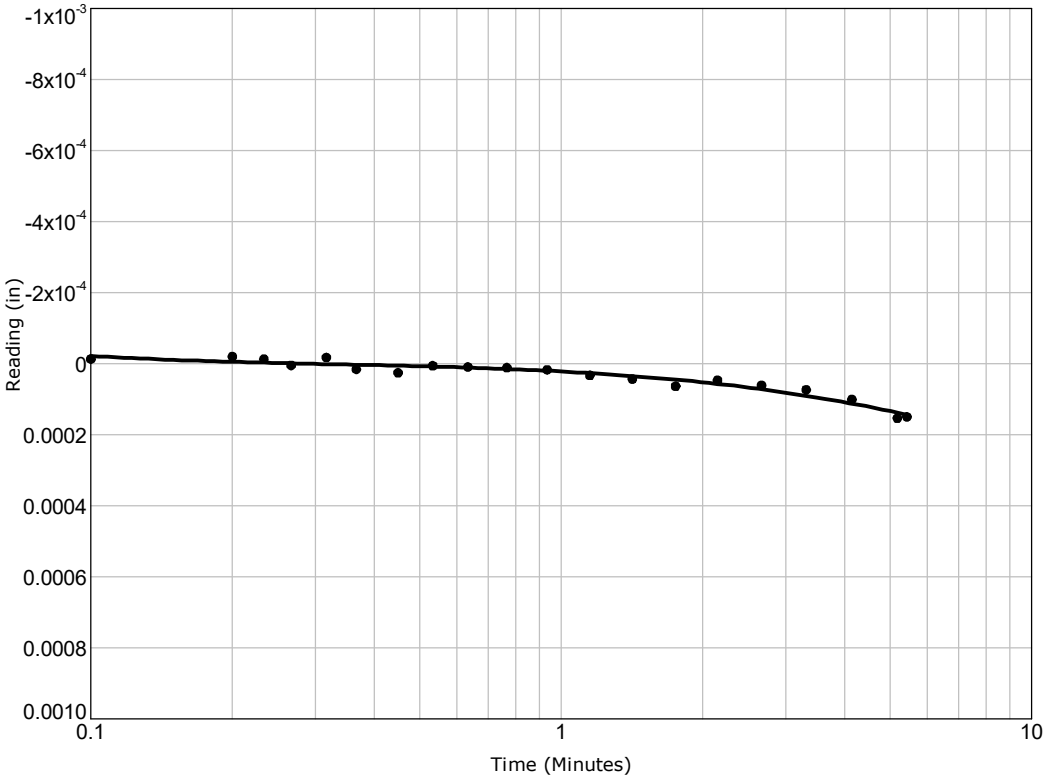
Borehole: BU24-02A Depth: 3 Specimen #: U-2



Load No. = 1

Load = 2500 psf

Borehole: BU24-02A Depth: 3 Specimen #: U-2



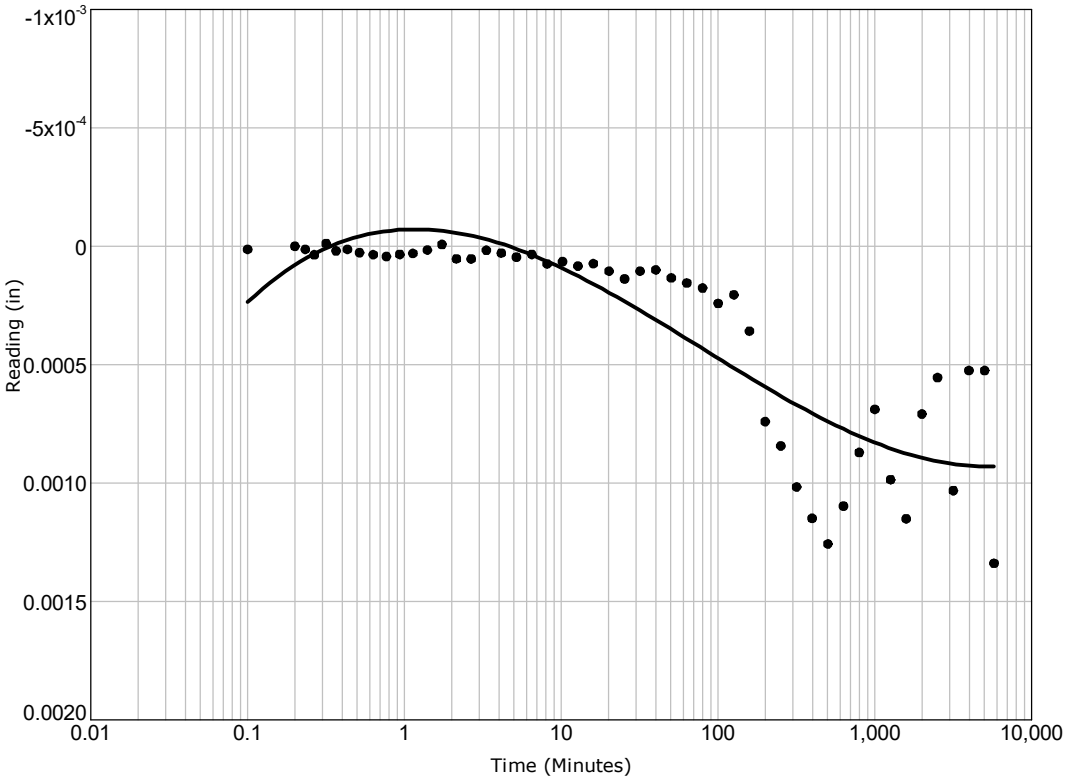
Load No. = 2

Load = 2500 psf

Time Deformation Curve

D4546

Borehole: BU24-02A Depth: 3 Specimen #: U-2

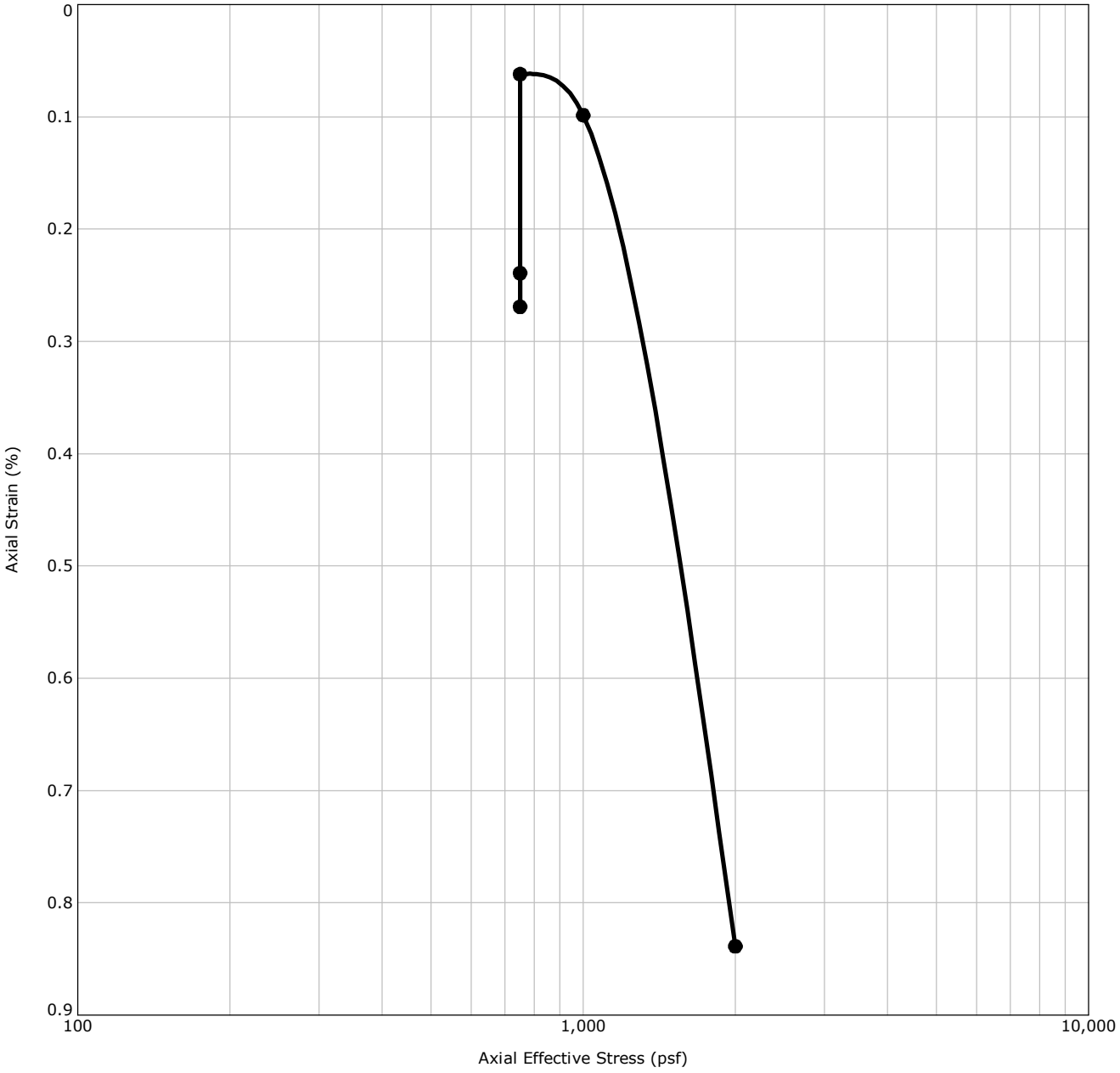


Load No. = 3

Load = 2500 psf

One-Dimensional Consolidation Test

D4546



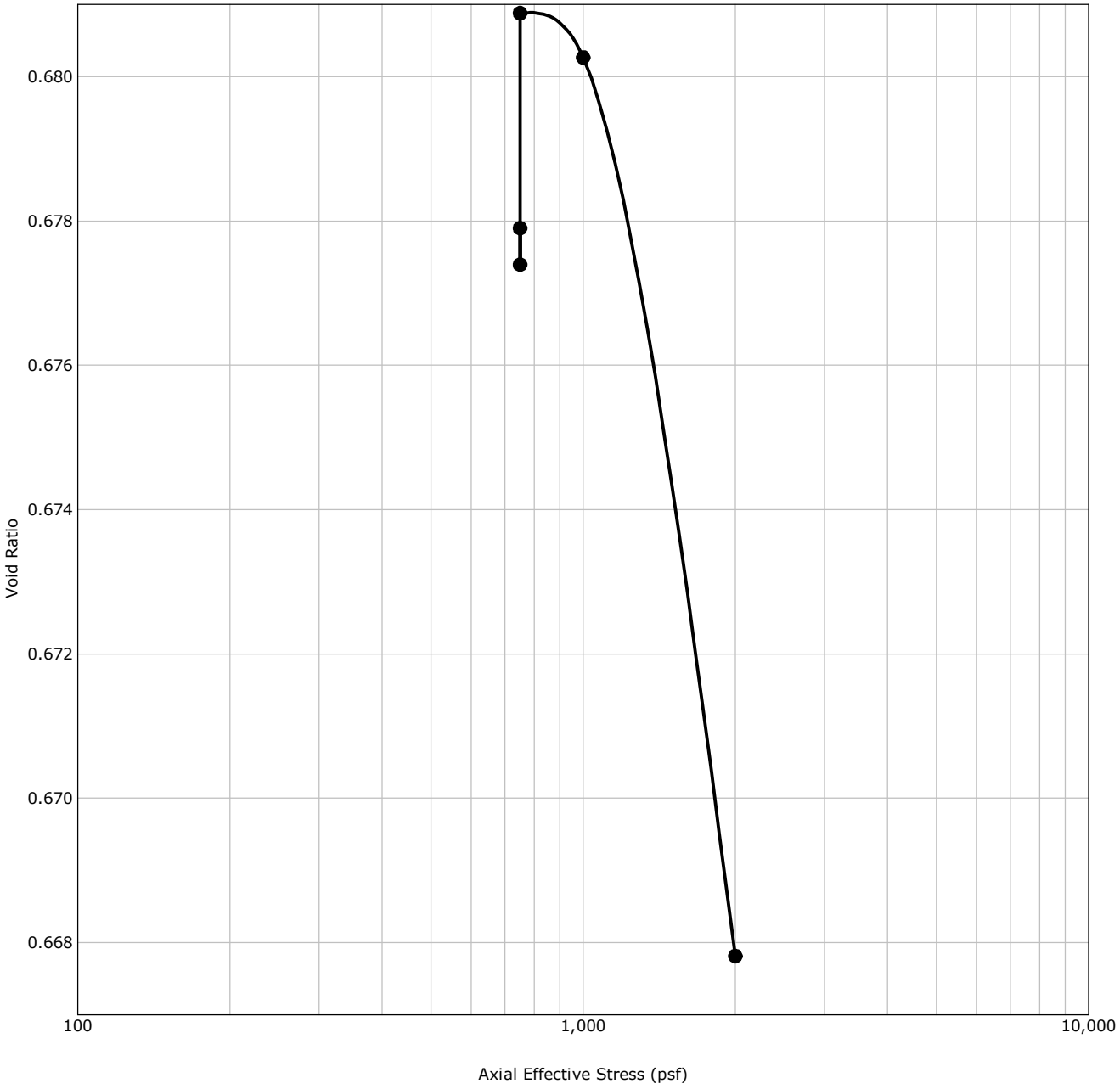
Boring ID	Depth (Ft)	Specimen #	Material Description	USCS	AASHTO
BU24-02A	5 - 7	U-3	10YR 5/4 Yellowish Brown	CL	A-7-6

Natural		Initial Dry Density (pcf)	LL	PI	Specific Gravity	Overburden (psf)	P_c (psf)	C_c (% / log stress)	C_r (% / log stress)	Initial Void Ratio
Saturation (%)	Moisture (%)									
74.4	18.8	100.2	44	27	2.70	600				

Notes: Swell %: 0.207
Specific gravity is assumed.
Test specimen cut from indicated sample; dry density and moisture content may vary from boring log.
Initial Diameter: 2.5 inches
Initial Height: 1 inch

One-Dimensional Consolidation Test

D4546



Boring ID	Depth (Ft)	Specimen #	Material Description	USCS	AASHTO
BU24-02A	5 - 7	U-3	10YR 5/4 Yellowish Brown	CL	A-7-6

Natural		Initial Dry Density (pcf)	LL	PI	Specific Gravity	Overburden (psf)	P_c (psf)	C_c (vr / log stress)	C_r (vr / log stress)	Initial Void Ratio
Saturation (%)	Moisture (%)									
74.4	18.8	100.2	44	27	2.70	600				

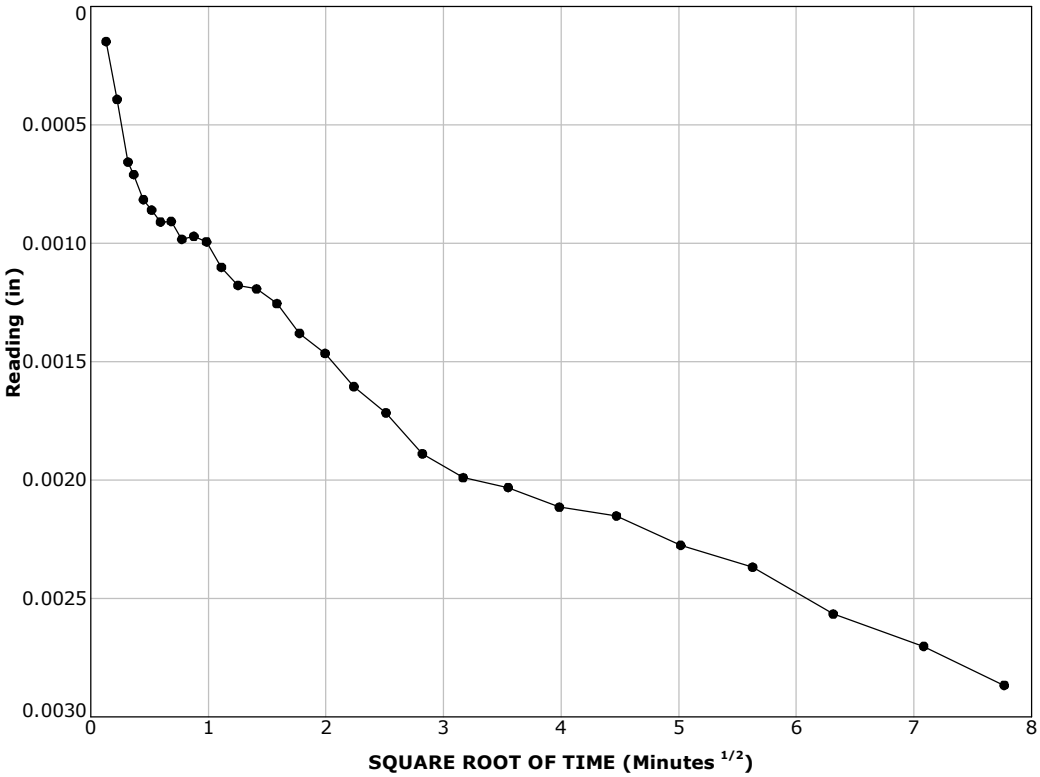
Notes: Swell %: 0.207
Specific gravity is assumed.
Test specimen cut from indicated sample; dry density and moisture content may vary from boring log.
Initial Diameter: 2.5 inches
Initial Height: 1 inch

15080 A Cir
Omaha, NE

Time Deformation Curve

D4546

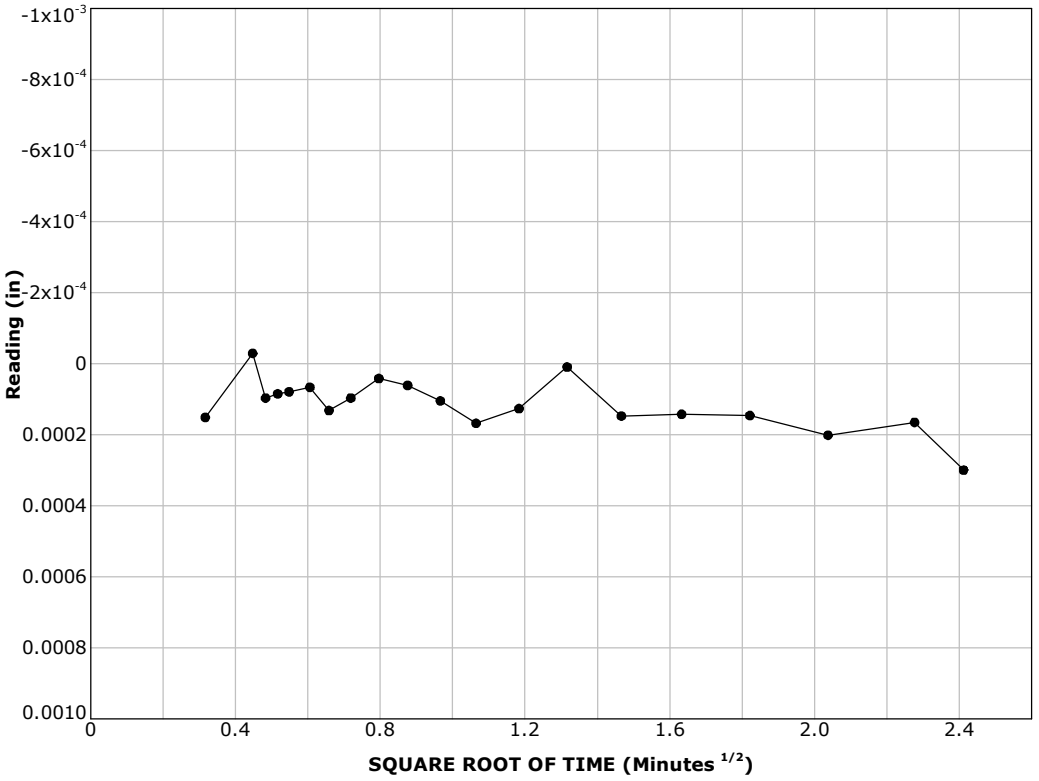
Borehole: BU24-02A Depth: 5 Specimen #: U-3



Load No. = 1

Load = 750 psf

Borehole: BU24-02A Depth: 5 Specimen #: U-3



Load No. = 2

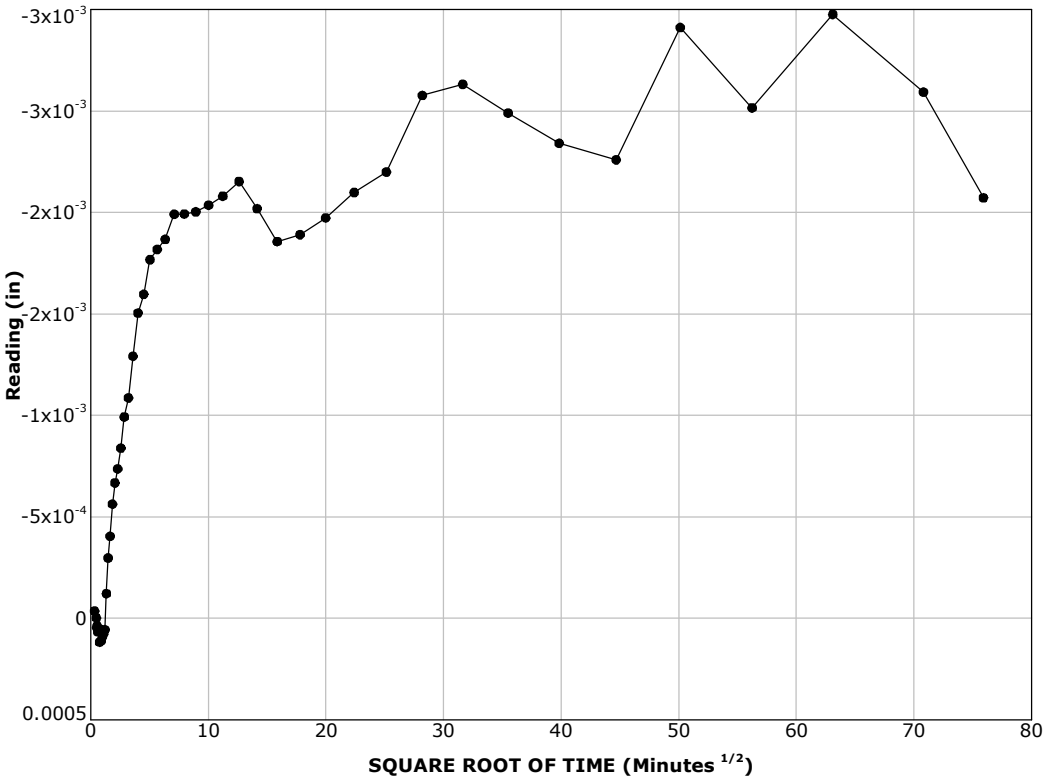
Load = 750 psf

15080 A Cir
Omaha, NE

Time Deformation Curve

D4546

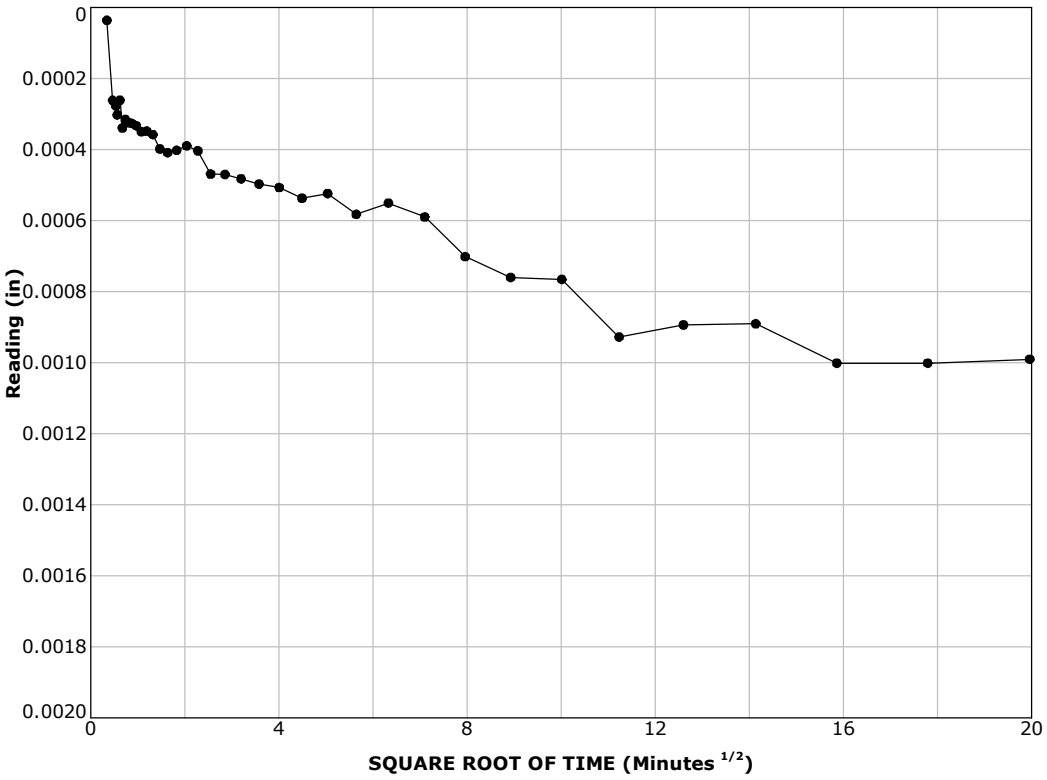
Borehole: BU24-02A Depth: 5 Specimen #: U-3



Load No. = 3

Load = 750 psf

Borehole: BU24-02A Depth: 5 Specimen #: U-3



Load No. = 4

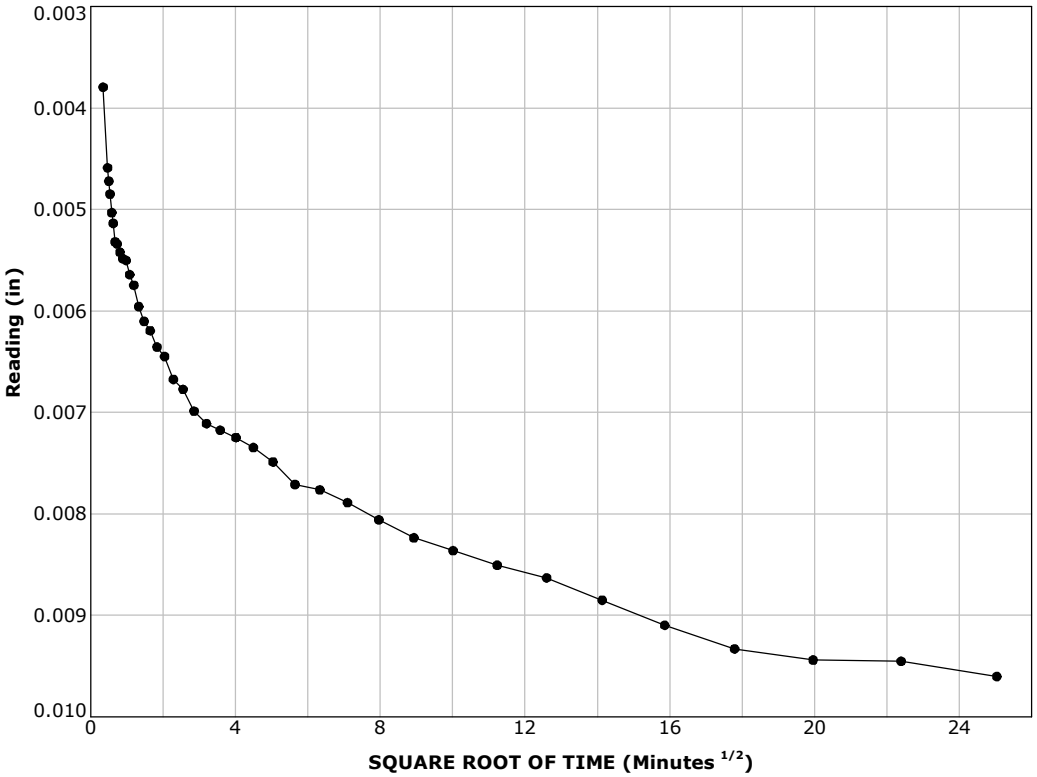
Load = 1000 psf

15080 A Cir
Omaha, NE

Time Deformation Curve

D4546

Borehole: BU24-02A Depth: 5 Specimen #: U-3



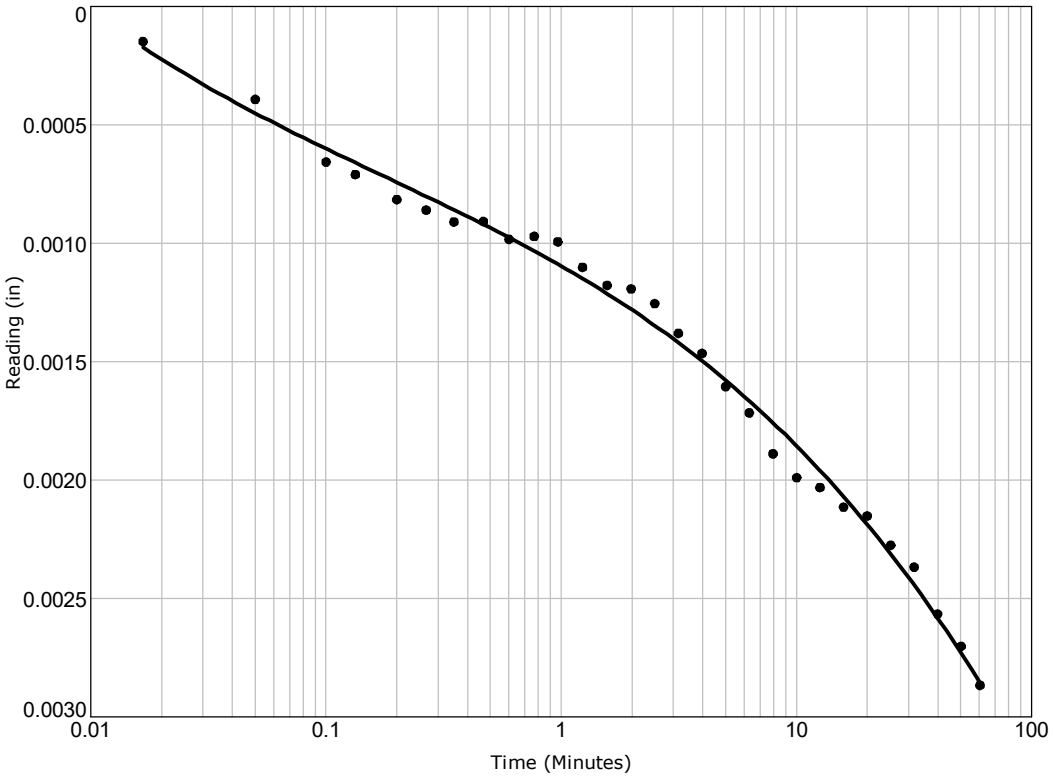
Load No. = 5

Load = 2000 psf

Time Deformation Curve

D4546

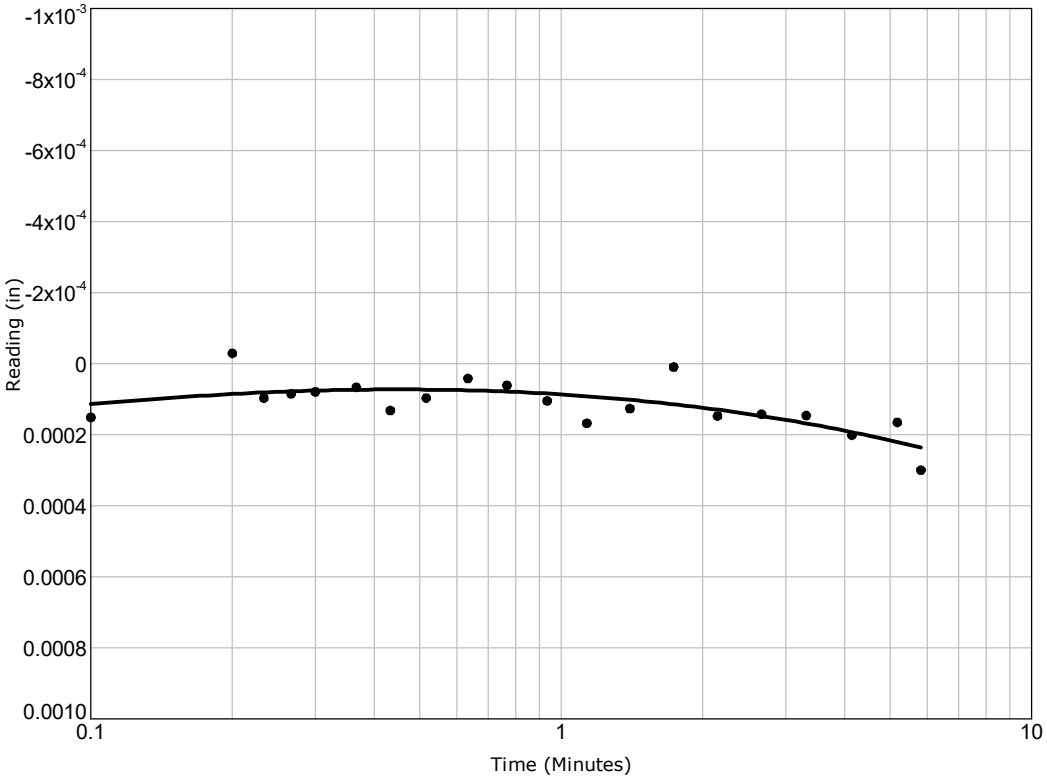
Borehole: BU24-02A Depth: 5 Specimen #: U-3



Load No. = 1

Load = 750 psf

Borehole: BU24-02A Depth: 5 Specimen #: U-3



Load No. = 2

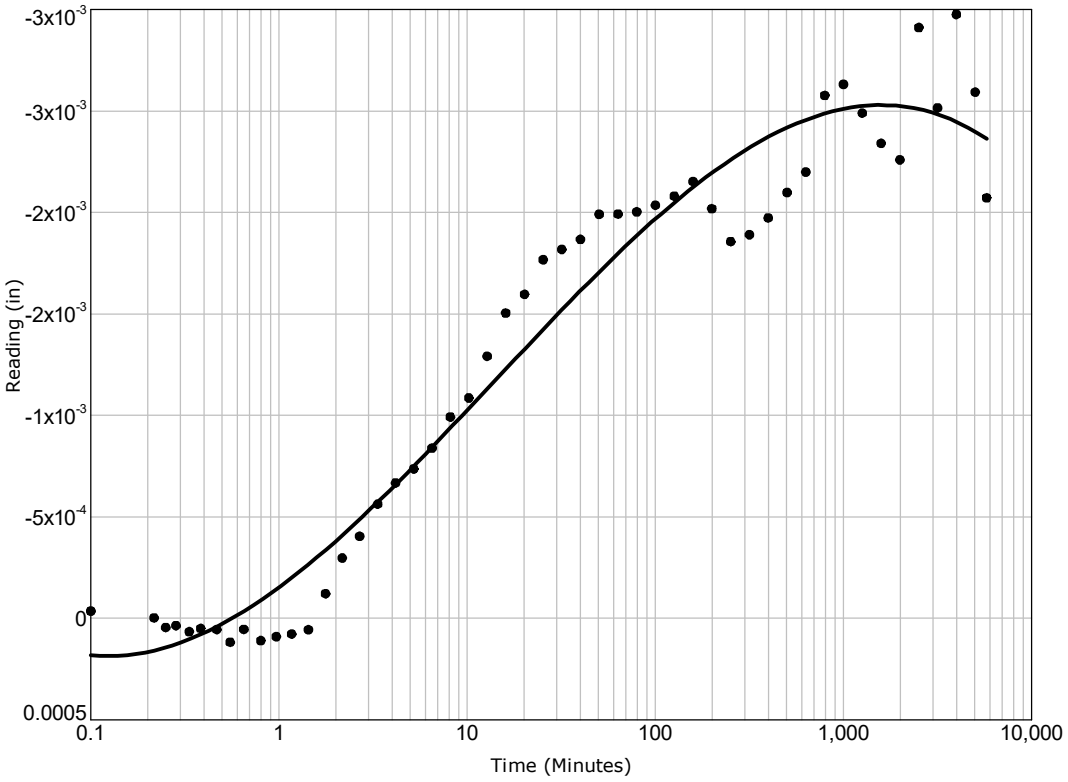
Load = 750 psf

15080 A Cir
Omaha, NE

Time Deformation Curve

D4546

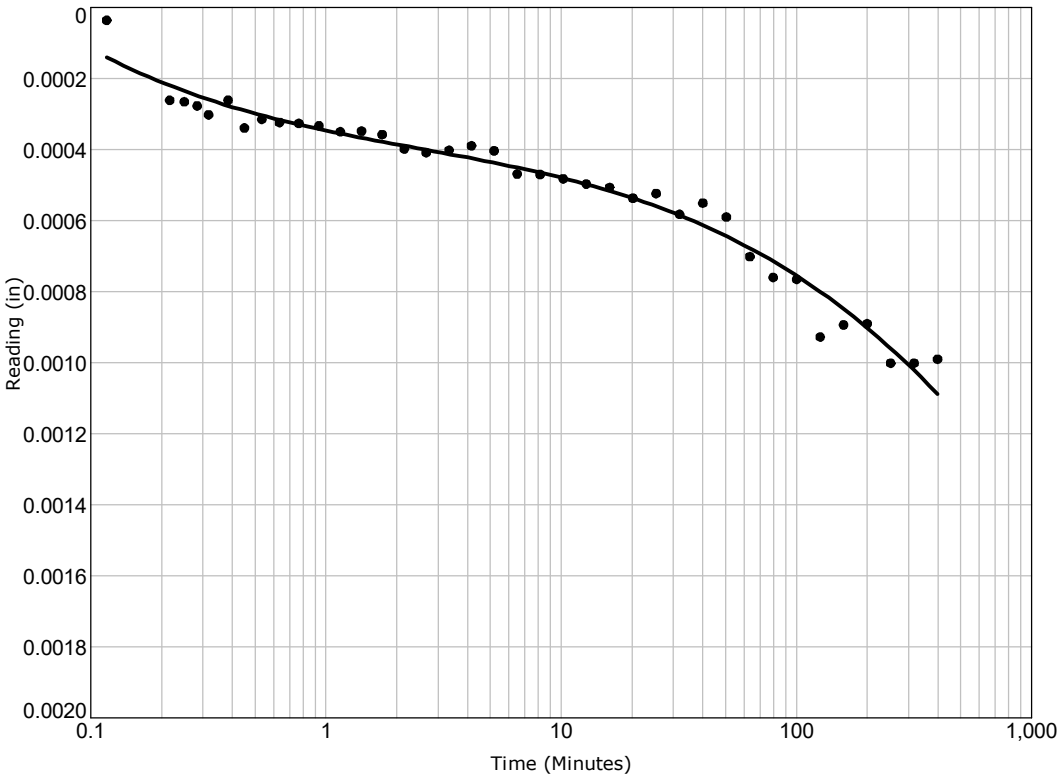
Borehole: BU24-02A Depth: 5 Specimen #: U-3



Load No. = 3

Load = 750 psf

Borehole: BU24-02A Depth: 5 Specimen #: U-3



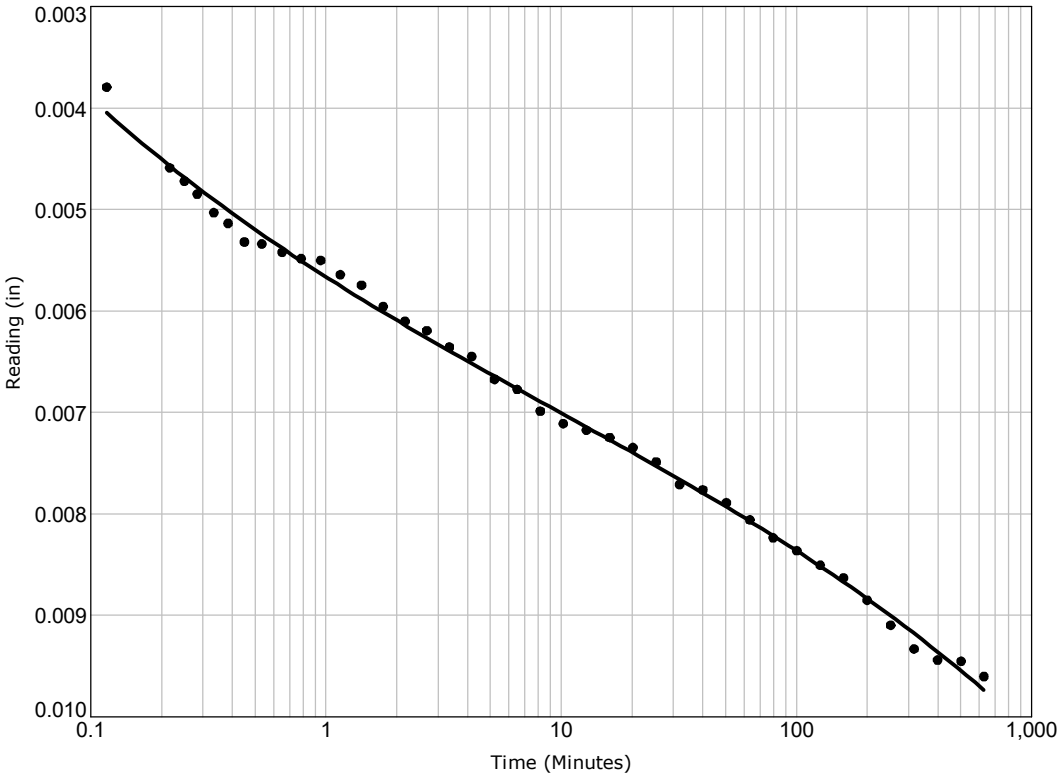
Load No. = 4

Load = 1000 psf

Time Deformation Curve

D4546

Borehole: BU24-02A Depth: 5 Specimen #: U-3

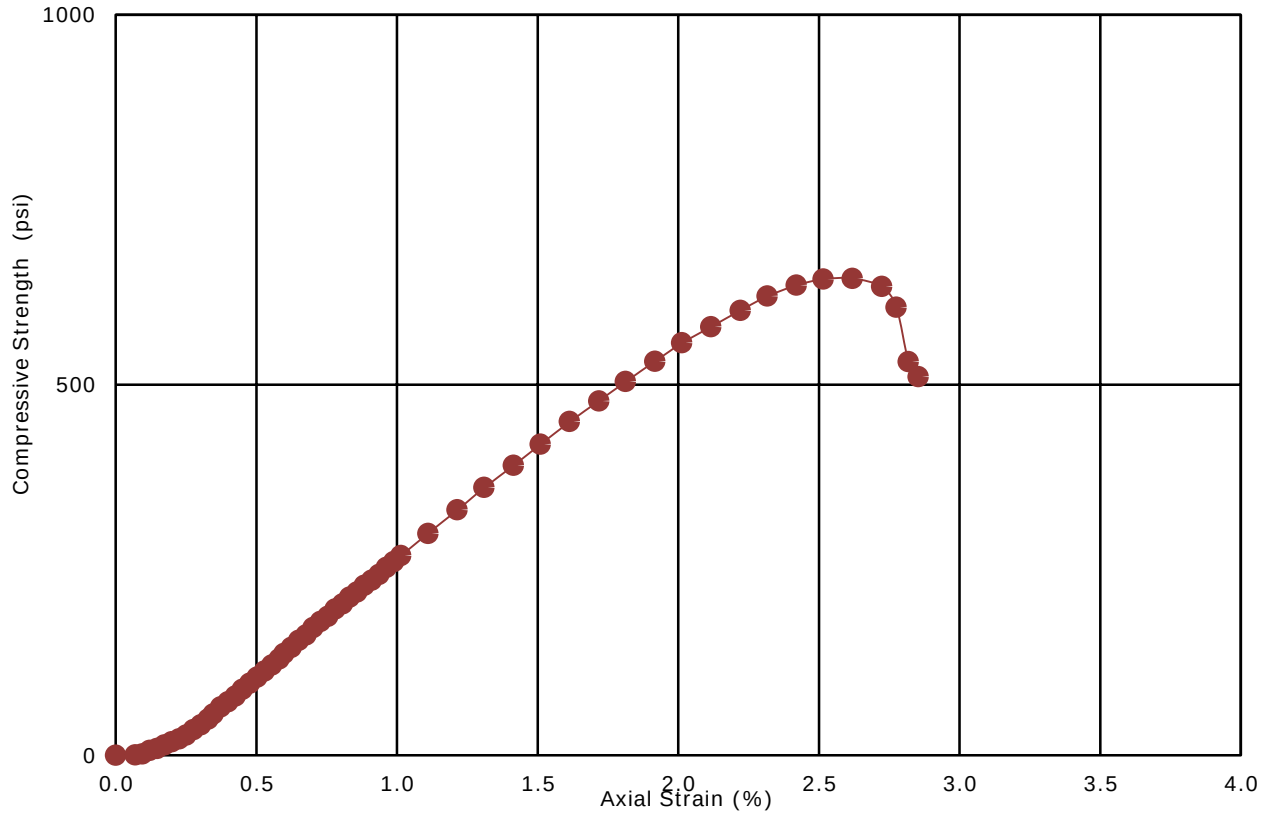


Load No. = 5

Load = 2000 psf

Terracon
15080 A Cir
Omaha, NE

Compressive Strength of Intact Rock Core Specimens
ASTM D7012 (Method C)



Boring ID	BU24-01	Sample No.	X1	Depth (ft)	69.6

Sample Description	5Y Olive Gray 4/2 Andesite		
Specific Gravity	2.70	Compressive Strength (psi)	640
Water Content (%)	9.4	Strain at Failure (%)	2.62
Dry Density (pcf)	106.9	Time to Failure (min)	0.11
Void Ratio	0.6	Rate of Loading (%/min)	24
Saturation (%)	44.1	Shear Strength (psi)	320
Initial Diameter (in)	3.313	Initial Length (in)	6.949
Length to Diameter Ratio	2.10	Sample Type	Rock Core
Tested by	T. Fellows	Test date	12/19/2024
Equipment	Sigma-1	Appearance after test	See Photo

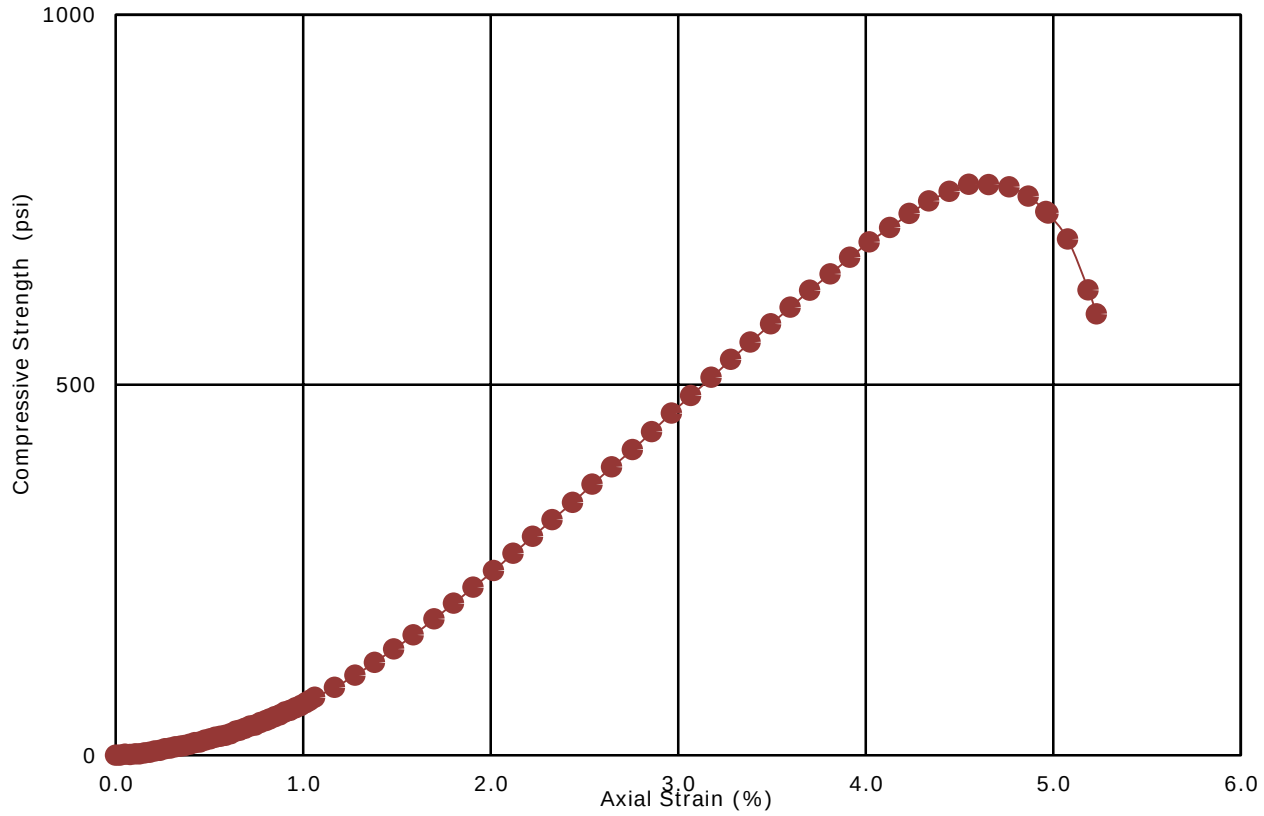

Before


After

Terracon
15080 A Cir
Omaha, NE

Compressive Strength of Intact Rock Core Specimens

ASTM D7012 (Method C)



Boring ID	BU24-02	Sample No.	X1	Depth (ft)	69.9

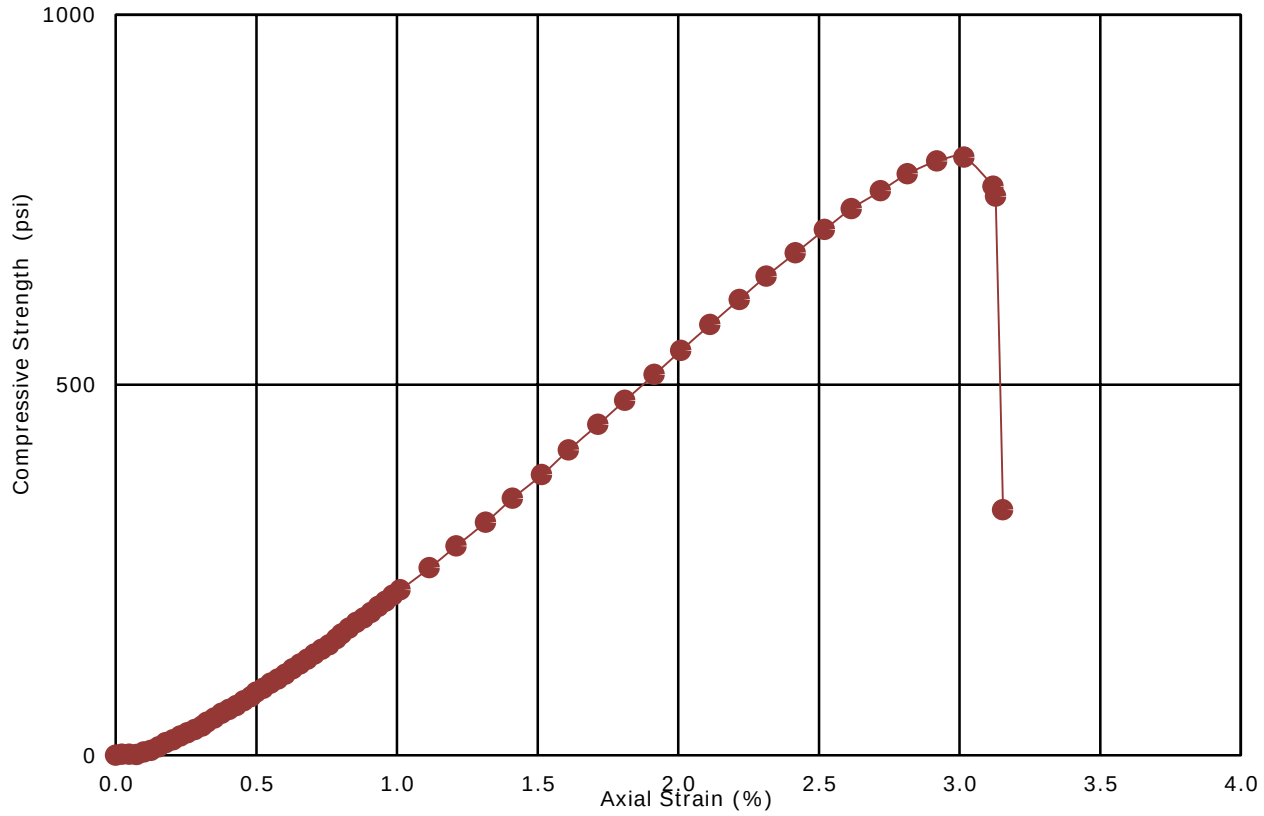
Sample Description	5Y Olive Gray 4/2 Andesite		
Specific Gravity	2.70	Compressive Strength (psi)	770
Water Content (%)	11.1	Strain at Failure (%)	4.55
Dry Density (pcf)	105.0	Time to Failure (min)	0.30
Void Ratio	0.6	Rate of Loading (%/min)	15
Saturation (%)	49.5	Shear Strength (psi)	390
Initial Diameter (in)	3.295	Initial Length (in)	4.438
Length to Diameter Ratio	1.35	Sample Type	Rock Core
Tested by	T. Fellows	Test date	12/19/2024
Equipment	Sigma-1	Appearance after test	See Photo

Before

After

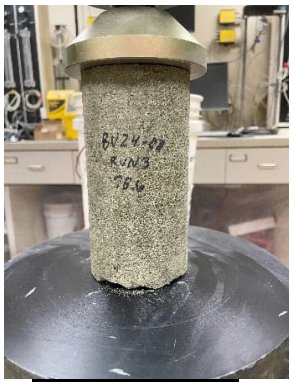
Terracon
15080 A Cir
Omaha, NE

Compressive Strength of Intact Rock Core Specimens
ASTM D7012 (Method C)



Boring ID	BU24-02	Sample No.	X2	Depth (ft)	78.6
Sample Description	5Y Olive Gray 4/2 Andesite				

Specific Gravity	2.70	Compressive Strength (psi)	810
Water Content (%)	12.0	Strain at Failure (%)	3.02
Dry Density (pcf)	98.0	Time to Failure (min)	0.13
Void Ratio	0.7	Rate of Loading (%/min)	24
Saturation (%)	45.0	Shear Strength (psi)	410
Initial Diameter (in)	3.292	Initial Length (in)	6.371
Length to Diameter Ratio	1.94	Sample Type	Rock Core
Tested by	T. Fellows	Test date	12/19/2024
Equipment	Sigma-1	Appearance after test	See Photo



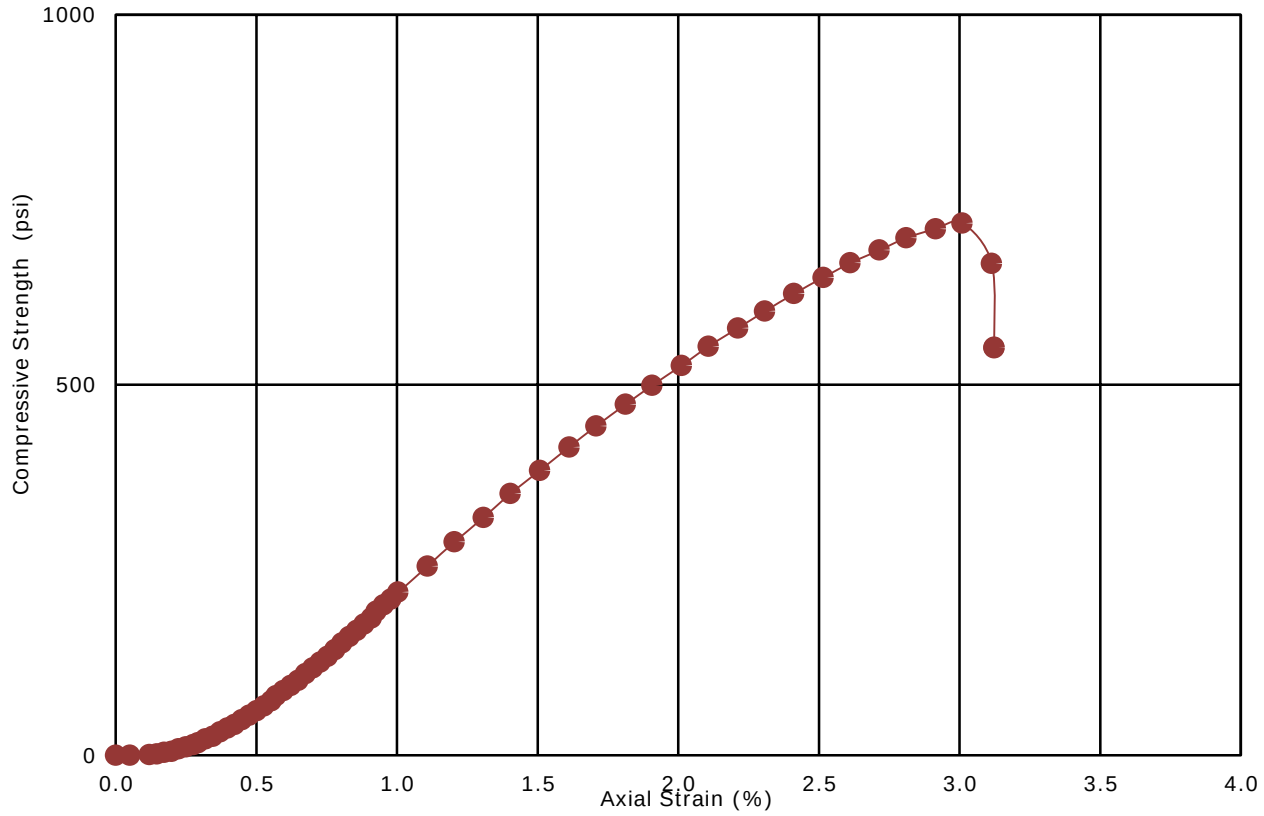
Before

After

Terracon
15080 A Cir
Omaha, NE

Compressive Strength of Intact Rock Core Specimens

ASTM D7012 (Method C)



Boring ID	BU24-03	Sample No.	X1	Depth (ft)	93

Sample Description	5Y Olive Gray 4/2 Andesite		
Specific Gravity	2.70	Compressive Strength (psi)	720
Water Content (%)	10.3	Strain at Failure (%)	3.01
Dry Density (pcf)	102.1	Time to Failure (min)	0.13
Void Ratio	0.7	Rate of Loading (%/min)	24
Saturation (%)	42.6	Shear Strength (psi)	360
Initial Diameter (in)	3.270	Initial Length (in)	7.061
Length to Diameter Ratio	2.16	Sample Type	Rock Core
Tested by	T. Fellows	Test date	12/19/2024
Equipment	Sigma-1	Appearance after test	See Photo

Before

After

Appendix D – Chemistry Test Results

General

Soil resistivity, pH, and sulfate tests were performed on one representative sample obtained from the depths indicated in the following table.

Chemistry Results				
Boring	**Depth (ft)**	**pH**	**Sulfate (ppm)**	**Resistivity (ohm-cm)**
BU24-01	3.0 – 4.5	7.34	Not detected	1,850
BU24-02	3.0 – 4.5	7.90	Not detected	1,700
BU24-03	1.0 – 2.5	7.72	110	1,000
BU24-04	3.0 – 4.5	9.54	481	1,100
BU24-05	5.5 – 7.0	7.61	Not detected	1,000

Sulfate Risk

Sulfate ion content tests were performed on the representative samples taken from the project site. Sulfate attack is an issue that can be damaging to foundations and concrete pavements. Based on criteria outlined in ACI 201.2, the on-site soils tested pose a low to moderate risk of sulfate attack. The sulfate risk classification outlined in ACI 201.2 is presented in the following table.

Sulfate Risk Classification [1]	
Exposure Classification	**Sulfate (SO_4^{2-}) in water (ppm)**
N/A	< 150
Moderate	150 to 1,500
Severe	1,500 to 10,000
Very Severe	> 10,000

1. From ACI 201.2R-16, *Guide to Durable Concrete*, November 2016.

Corrosion Potential

Soils having a pH of 8 (alkaline) or above can lead to extreme corrosion rates and premature pitting of metallic objects. Chemistry testing revealed that the on-site soils generally have pH values less than 8; however, one sample had a pH of 9.54 in the area of boring BH24-04.

Resistivity tests gage the corrosion potential of soil. Based on criteria outlined in the following table, the on-site soils present a severe risk for corrosion potential.

Soil Resistivity Classification		
Resistance Classification	**Soil Resistivity (ohm-cm)**	**Corrosion Potential**
Low	0 to 2,000	Severe
Medium	2,000 to 10,000	Moderate
High	10,000 to 30,000	Mild
Very High	> 30,000	Unlikely

There are several methods of preventing corrosion of buried pipes, though most of these methods are only practical for application prior to installation of the piping. Design engineers should consider the use of nonmetallic pipes for underground utilities. However, if steel pipes and/or foundations are used, design engineers may increase the thickness of steel members and/or steel-walled pipes. Structural reinforcing steel can also be subject to corrosion. Typical mitigation methods include incorporating epoxy-coated steel or non-metallic reinforcement and wire. Cathodic protection is another common method to control corrosion. Incorporating cathodic protection early on can prevent corrosion from the start.

902 Industrial Way
Lodi, California 95240
(209) 367-3701

Client
US Army Corps of Engineers (USACE)

Project
PIMCS Buckley SFB Soil Testing

Sample Submitted By: Terracon (05) **Date Received:** 11/19/2024 **Project Number:** 05241404

Results of Corrosion Analysis

Sample Boring	BU24-01	BU24-02	BU24-03
Sample Number	D-2	D-2	D-1
Sample Depth (ft.)	3.0 - 4.5	3.0 - 4.5	1.0 - 2.5
pH Analysis, ASTM G 51	7.34	7.90	7.72
Saturated Minimum Resistivity, ASTM G 57, (ohm-cm)	1,850	1,700	1,000

Reviewed By: Paula Arends
Paula Arends
Laboratory Manager

The tests were performed in general accordance with applicable ASTM and AWWA test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

902 Industrial Way
Lodi, California 95240
(209) 367-3701

Client
US Army Corps of Engineers (USACE)

Project
PIMCS Buckley SFB Soil Testing

Sample Submitted By: Terracon (05) **Date Received:** 11/19/2024 **Project Number:** 05241404

Results of Corrosion Analysis

Sample Boring	BU24-04	BU24-05
Sample Number	D-2	D-3
Sample Depth (ft.)	3.0 - 4.5	5.5 - 7.0
pH Analysis, ASTM G 51	9.54	7.61
Saturated Minimum Resistivity, ASTM G 57, (ohm-cm)	1,100	1,000

Reviewed By: Paula Arends
Paula Arends
Laboratory Manager

The tests were performed in general accordance with applicable ASTM and AWWA test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

REPORT NUMBER
24-324-4171

REPORT DATE
Nov 19, 2024

SEND TO
12985

RECEIVED DATE
Nov 15, 2024

Midwest Laboratories®
13611 B Street • Omaha, Nebraska 68144-3693 • (402) 334-7770
www.midwestlabs.com

ISSUE DATE
Nov 19, 2024

TERRACON INC
TYLER FELLOWS
15080 A CIR
OMAHA NE 68144-

REPORT OF ANALYSIS

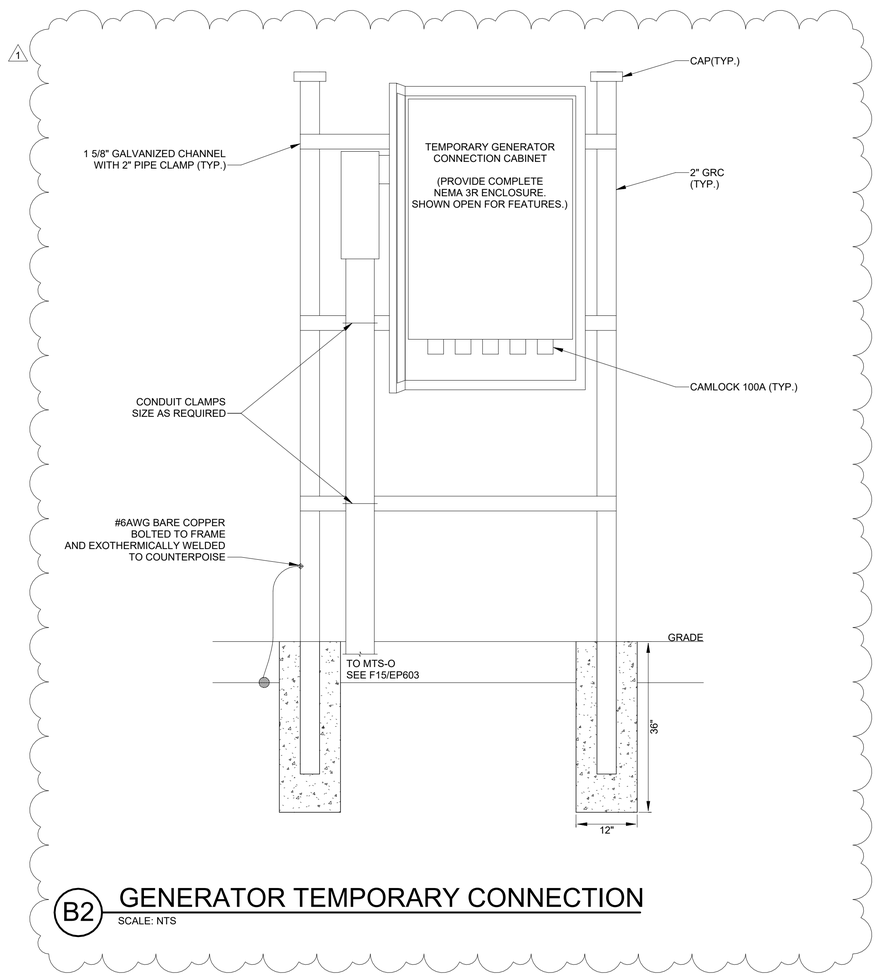
For: (12985) TERRACON INC
PIMCS Buckley SFB Soil Testing
05241404

Analysis	Level Found As Received	Units	Reporting Limit	Method	Analyst-Date	Verified-Date
Sample ID: **BU24-01 D-2 3-4.5** Lab Number: **70553900** Date Sampled: **2024-11-14**						
Sulfate	n.d.	mg/kg	76	EPA 9056A *	jsp9-2024/11/18	jdb5-2024/11/19
Sample ID: **BU24-02 D-2 5.5-7** Lab Number: **70553901** Date Sampled: **2024-11-14**						
Sulfate	n.d.	mg/kg	73	EPA 9056A *	jsp9-2024/11/18	jdb5-2024/11/19
Sample ID: **BU24-03 D-1 1-2.5** Lab Number: **70553902** Date Sampled: **2024-11-14**						
Sulfate	110	mg/kg	75	EPA 9056A *	jsp9-2024/11/18	jdb5-2024/11/19
Sample ID: **BU24-04 D-2 3-4.5** Lab Number: **70553903** Date Sampled: **2024-11-14**						
Sulfate	481	mg/kg	73	EPA 9056A *	jsp9-2024/11/18	jdb5-2024/11/19
Sample ID: **BU24-05 D-3 5.5-7** Lab Number: **70553904** Date Sampled: **2024-11-14**						
Sulfate	n.d.	mg/kg	73	EPA 9056A *	jsp9-2024/11/18	jdb5-2024/11/19

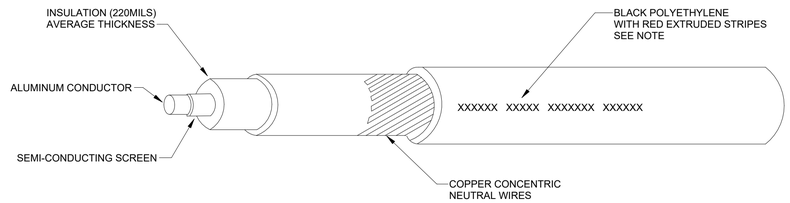
All results are reported on an AS RECEIVED basis, n.d. = not detected , ppm = parts per million, ppm = mg/kg

For questions please contact:

Kerri Stanek
Account Manager
kstanek@midwestlabs.com (402)590-2982



B2 GENERATOR TEMPORARY CONNECTION
SCALE: NTS



CONDUCTOR: UNCOATED ALUMINUM, CLASS B STRANDED PER ASTM B-231, CONTINUOUS OPERATING TEMPERATURES 105 C, SHORT CIRCUIT RATING 250C WITH EXTRUDED EPR SEMI-CONDUCTING STRAND SHIELD.

INSULATION: ETHYLENE-PROPYLENE (EPR), NOT LESS THAN 220 MILS AVERAGE THICKNESS (200 MILS MINIMUM THICKNESS), 133% INSULATION LEVEL WITH AN EXTRUDED SEMI-CONDUCTING SCREEN. OTHER INSULATION TYPES SHALL NOT BE MIXED WITH EPR.

CONCENTRIC NEUTRAL: BARE COPPER WIRES SPACED UNIFORMLY AROUND INSULATION SCREEN, NUMBER AND SIZE AS SHOWN.

JACKET: BLACK POLYETHYLENE WITH RED EXTRUDED STRIPES. SUNLIGHT RESISTANT. SUITABLE FOR WET LOCATIONS, DRY LOCATIONS, IN CONDUIT, UNDERGROUND DUCT SYSTEMS, DIRECT BURIED, AND AERIAL INSTALLATIONS.

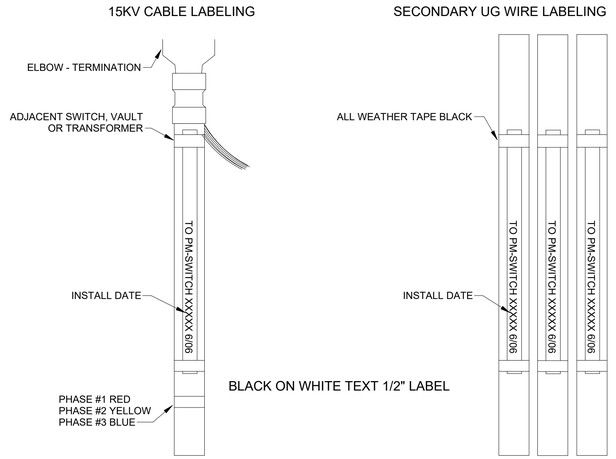
FACTORY TESTS: CABLE TO MEET THE REQUIREMENTS OF NEMA WC-8, AIEC CS6, UL 1072.

CABLES TO BE PROVIDED WITH DIRECTION TAGS.

SIZE	NUMBER OF STRANDS	AMPACITY	APPROXIMATE DIAMETER OVER INSULATIONS	CU NEUTRAL (NO. X AWG)	MAXIMUM OUTSIDE DIAMETER	CONDUIT
350 (1/3 NEUTRAL)	37	305	1.18 (IN.)	18 X 14	1.52 (IN.)	6"
4/0 (1/3 NEUTRAL)	19	200	1.02 (IN.)	12 X 14	1.33 (IN.)	4"
#2 (FULL NEUTRAL)	7	100	0.78 (IN.)	10 X 14	1.09 (IN.)	2" - 4"

NOTE:
A DURABLE MARKING TO BE PROVIDED ON THE SURFACE OF THE CABLE AT INTERVALS NOT EXCEEDING 24 INCHES. MARKING SHALL INCLUDE MANUFACTURER'S NAME, INSULATION TYPE, CONDUCTOR SIZE, VOLTAGE, INSULATION LEVEL, FOOTAGE, AND DATE OF MANUFACTURE.

J13 15KV CABLE
SCALE: NTS



B13 CABLE LABELING
SCALE: NTS

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE
1	AM #0004 - GENERAL REVISIONS	10/07/2025

File Path: C:\Users\jfieldsem\Documents\BUCO00102_DM_ME_jfieldsem.rvt

ISSUE DATE: 05/01/2025
SOLICITATION NO.: W9128F25RA043
CONTRACT NO.:

DESIGNED BY: E.MCNAMARA
DRAWN BY: E.MCNAMARA
CHECKED BY: B.ADKINS
SUBMITTED BY: J.HOPPER
SIZE: ANSI D
FILE NAME: BUCO00102_DM_ME.rvt

Date: 10/3/2025 10:19:07 AM
Plot Date: 10/3/2025 10:19:10 AM

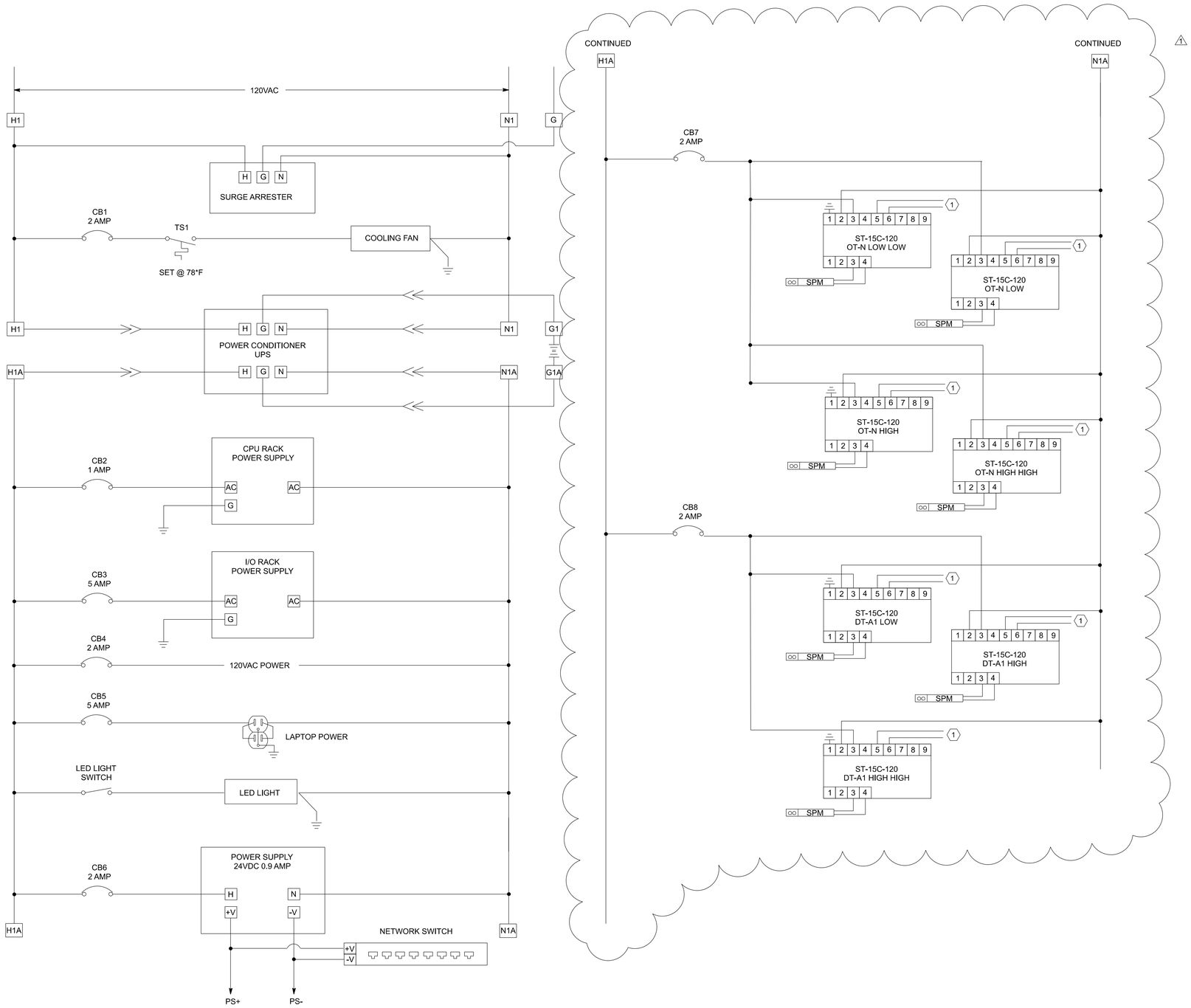
US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVE.
OMAHA, NE 68102

BUCKLEY SFB, COLORADO
POWER INDEPENDENCE: MISSION CONTROL STATION

ELECTRICAL SITE DETAILS

SHEET ID
ES505

ADVERTISEMENT



GENERAL NOTES

1. (01) LEVEL SWITCH CONTROL MODULES FOR TANKS OT-S, DT-B1, AND DT-B2 ARE LOCATED IN PCP-B.

SHEET KEY NOTES

1. (01) CONNECTIONS MADE TO PLC INPUT

ADVERTISEMENT

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE
1	AM #0004 - GENERAL REVISSIONS	10/07/2025

P:\09Q4_PROJECTS\BUCO00102\PLAN SETS\03_SHEETS\03_SITE\BUCO00102-EF501-601.DWG
12:38:03 PM 11/30/2023
G6EDJXPFW
AEC_NCS_4_MONO.CTB

DESIGNED BY: C.RAISON
DRAWN BY: C.RAISON
CHECKED BY: P.WAGNER
SUBMITTED BY: S. LINDGREN
SIZE: ANSI D
ISSUE DATE: 05/01/2025
SOLICITATION NO.: W9126F25RA043
CONTRACT NO.:
FILE NUMBER:
FILENAME: BUCO00102-EF501-601.dwg

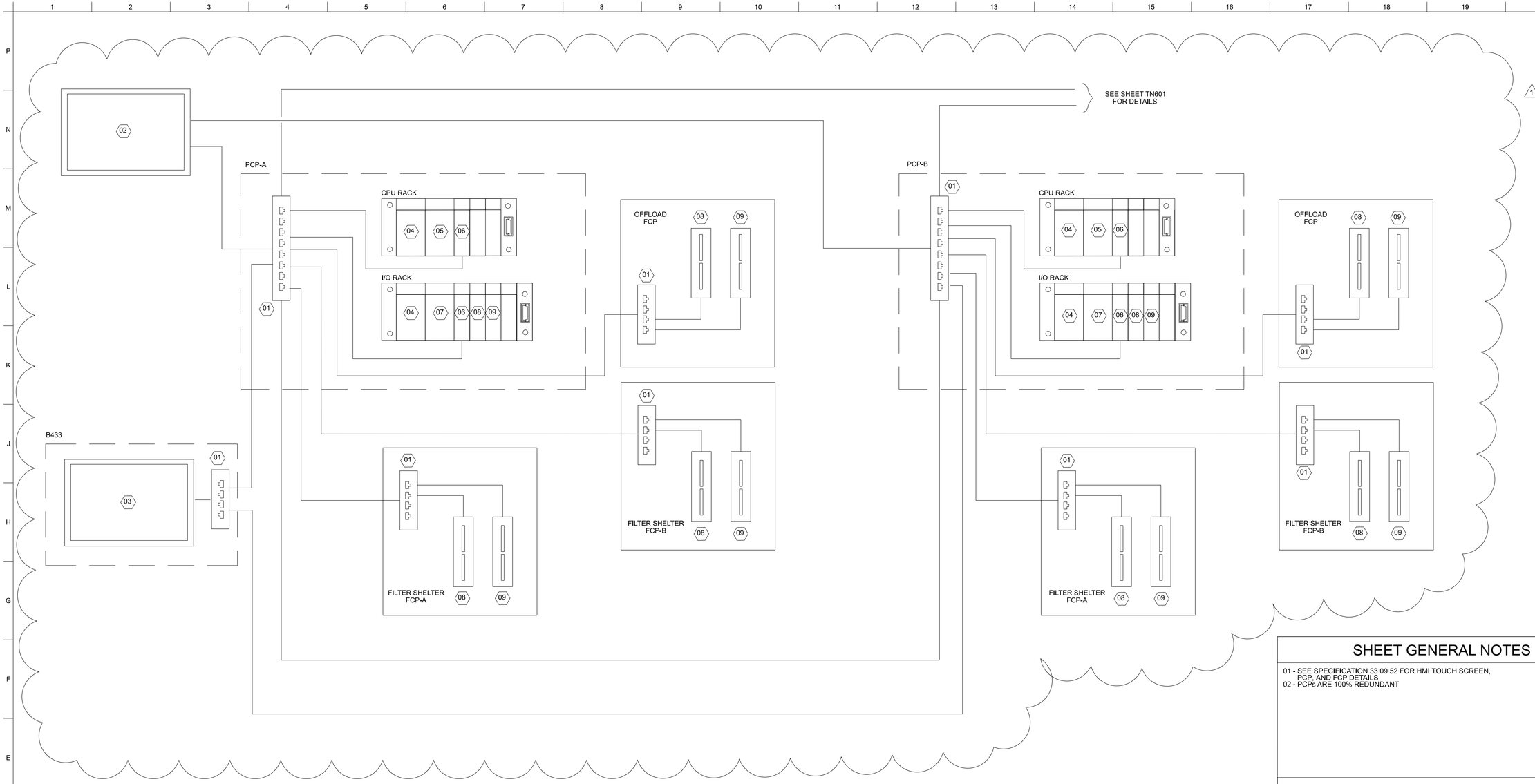
U.S. ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVE
OMAHA, NE 68102

BUCKLEY SFB, COLORADO
POWER INDEPENDENCE, MISSION CONTROL STATION

PUMP CONTROL PANEL POWER DISTRIBUTION DIAGRAM

SHEET ID

EF513



SHEET GENERAL NOTES

01 - SEE SPECIFICATION 33 09 52 FOR HMI TOUCH SCREEN, PCP, AND FCP DETAILS
02 - PCPs ARE 100% REDUNDANT

SHEET KEY NOTES

01 - NETWORK SWITCH
02 - FUELING SYSTEM CONTROL HMI TOUCH SCREEN AT B451
03 - FUELING SYSTEM CONTROL HMI TOUCH SCREEN AT B433
04 - POWER SUPPLY MODULE
05 - CPU MODULE
06 - COMMUNICATIONS MODULE
07 - NETWORK INTERFACE MODULE
08 - DISCRETE INPUT MODULE
09 - DISCRETE OUTPUT MODULE

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2	AM #0004 - GENERAL REVISIONS	10/07/2025
1	AM #0003 - GENERAL REVISIONS	09/29/2025

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DESIGNED BY: C.RAISON
DRAWN BY: C.RAISON
CHECKED BY: P.SWISHER
SUBMITTED BY: S. LINDGREN
SIZE: ANSI D
ISSUE DATE: 05/01/2025
SOLICITATION NO.: W9126F25RA043
CONTRACT NO.:
FILE NUMBER:
FILENAME: BUCO00102-EF501-601.dwg

U.S. ARMY CORPS OF ENGINEERS
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OMAHA, NE 68102

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POWER INDEPENDENCE: MISSION CONTROL STATION

CONTROL SYSTEM DIAGRAM

SHEET ID
EF514

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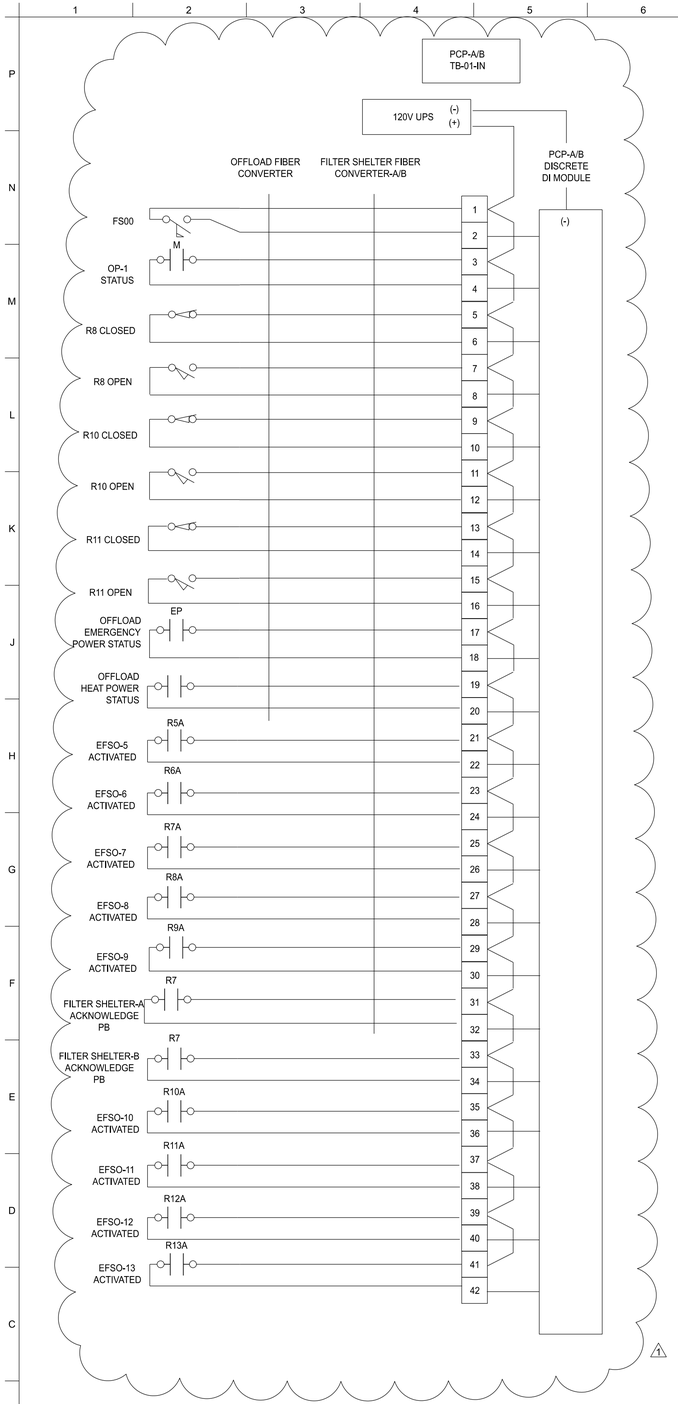

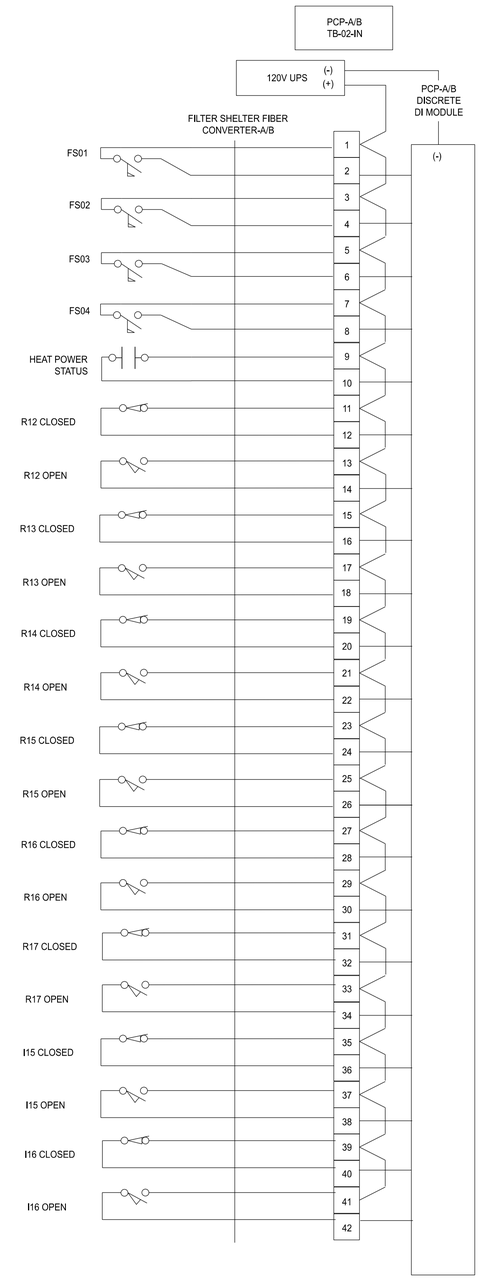

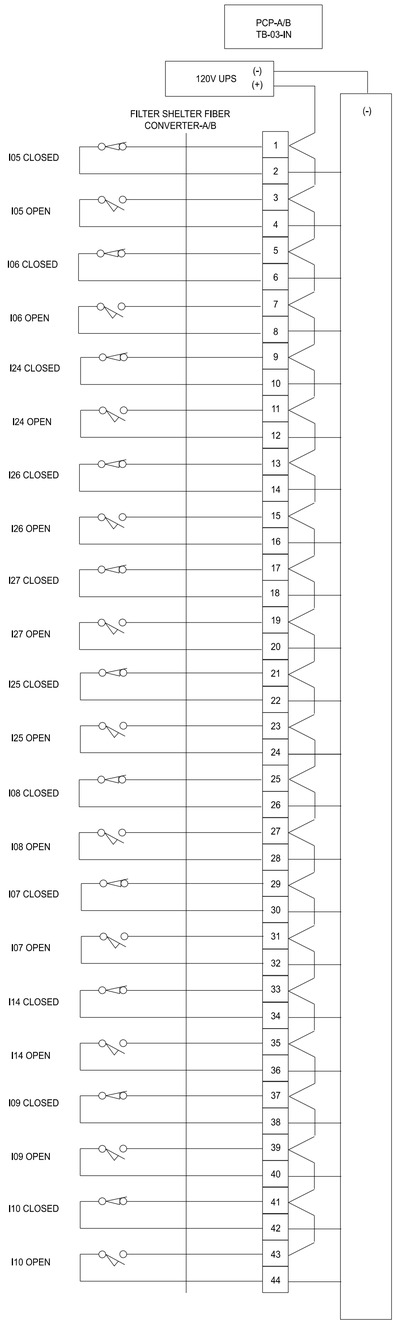

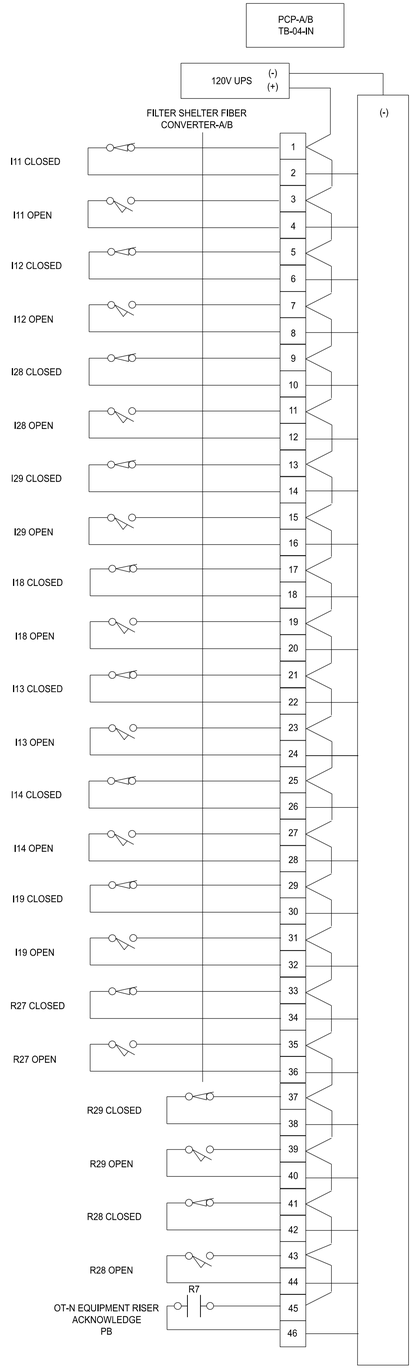

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TERMINAL BLOCK CONNECTIONS
(FOR FIELD DEVICES) SHEET 1 OF 3

SHEET ID

EF515

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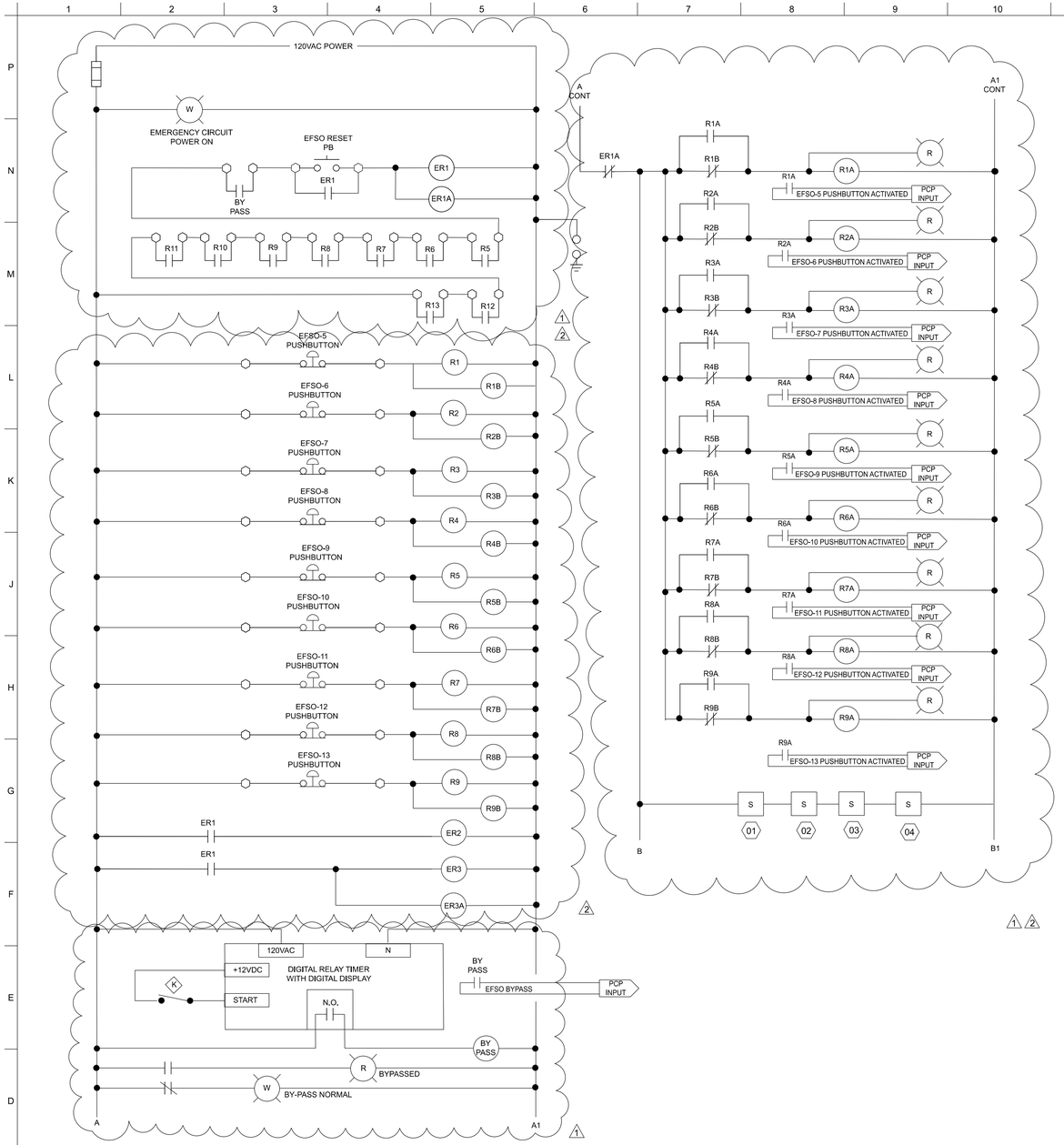

B1 EFSO CONTROL SYSTEM DIAGRAM

GENERAL SHEET NOTES

01 - OFFLOAD EFSO SYSTEM AND EFSO SYSTEM SHALL NOT BE INTEGRATED. OFFLOAD EFSO SYSTEM SHALL SEND AN EFSO STATUS SIGNAL TO THE PCP.
02 - ACKNOWLEDGE PB SHALL CANCEL HORNS AND STROBES SHALL CONTINUE TO FLASH UNTIL EFSO SYSTEM IS MANUALLY RESET
03 - EFSO SYSTEM COMPONENTS SHALL BE INTEGRATED INTO PCP-A UNLESS INDICATED OTHERWISE. EFSO SYSTEM SHALL HAVE A DEDICATED 120V BRANCH CIRCUIT
04 - DIGITAL RELAY TIMER WITH DIGITAL DISPLAY PERFORMS THE FUNCTION OF A BYPASS COUNTDOWN TIMER. THE DIGITAL DISPLAY SHALL SHOW THE SETPOINT VALUE (SV) OF 0 SECONDS AND THE PRESENT VALUE (PV) READING IN HOURS, MINUTES AND SECONDS (COUNTDOWN TO START AT 24 HOURS AND SHALL COUNTDOWN IN 1 SECOND INCREMENTS). THE DIGITAL RELAY TIMER SHALL HAVE A "RESET" BUTTON LOCATED ON THE FRONT OF THE UNIT, NEXT TO THE DISPLAY (ACCESSIBLE ON FRONT OF PANEL), THAT WHEN PRESSED WILL RESET THE COUNTDOWN TIMER TO 24 HOURS. THIS "RESET" WILL REMOVE THE BYPASS FOR THAT AREA. THE DIGITAL RELAY TIMER SHALL BE CAPABLE OF LOCKING THE KEYPAD WHILE STILL ALLOWING THE "RESET" BUTTON REMAIN FUNCTIONAL. DIGITAL RELAY TIMER IS BASED ON:
MANUFACTURER: AUTOMATION DIRECT MODEL: CTT-1C-A120
TIMER SETTING: SIGNAL OFF DELAY "SOFFD", TIMING DOWN.
KEYPAD LOCK SETTING: "LOCK 2" ("RESET" FUNCTIONAL)
05 - OUTPUT CONTACT SHALL CLOSE WHILE COUNTDOWN TIMER IS COUNTING DOWN OR WHILE DURING THE COUNTDOWN TIMER, PAUSE IS PRESSED. OUTPUT CONTACT SHALL OPEN WHEN COUNTDOWN TIMER IS AT 24 HOURS (PRIOR TO COUNTING DOWN), WHEN COUNTDOWN TIMER REACHES 0 SECONDS (END OF COUNTDOWN), WHEN RESET IS PRESSED. ON LOSS OF POWER TO THE DIGITAL RELAY TIMER, THE OUTPUT CONTACTS SHALL OPEN.

SHEET KEY NOTES

01 - STROBE LOCATED OUTSIDE PUMP CONTROL ROOM A
02 - STROBE LOCATED OUTSIDE PUMP CONTROL ROOM B
03 - STROBE LOCATED AT OT-N EQUIPMENT RISER
04 - STORBE LOCATED AT FILTER SHELTER EQUIPMENT RISER
05 - RESONATING HORN LOCATED ON WEST SIDE OF B451 NEAR OT-N EQUIPMENT RISER
06 - RESONATING HORN LOCATED PUMP CONTROL ROOM A
06 - RESONATING HORN LOCATED PUMP CONTROL ROOM B

LEGEND

K - KEYED INTERLOCK
- KEYED SWITCH INTERCONNECTION (WHEN PLACED IN BY-PASS, THIS CONNECTION IS ALSO MADE)

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DESIGNED BY: M. MERWALD
DRAWN BY: M. MERWALD
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SUBMITTED BY: S. LINDGREN
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EFSO SYSTEM CONTROL DIAGRAM

SHEET ID
EF529

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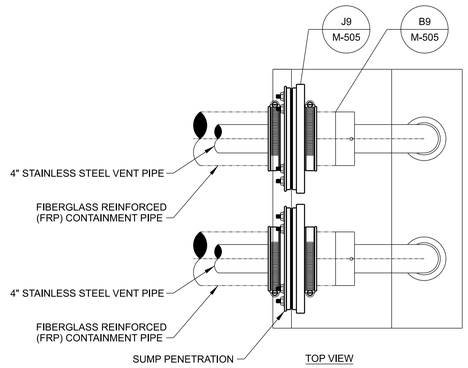
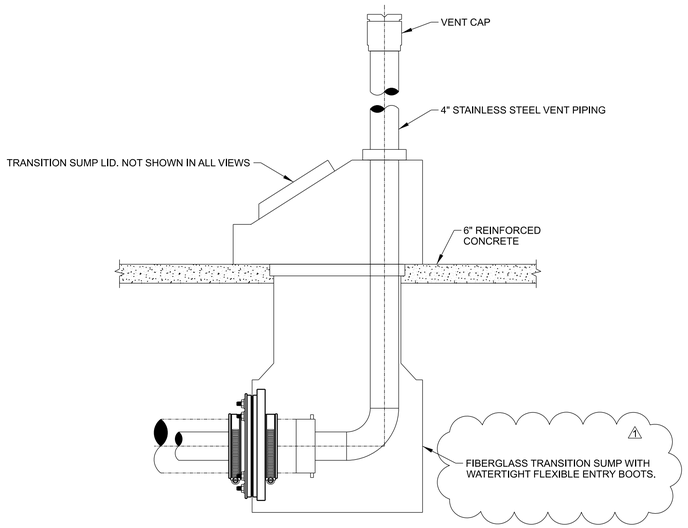
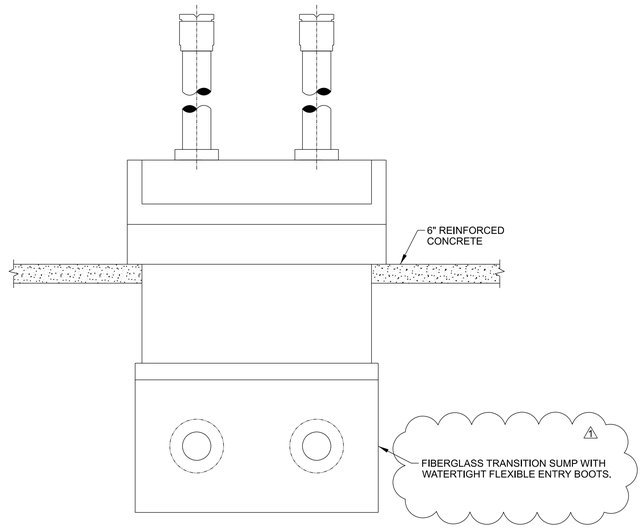


TOP VIEW



SIDE VIEW

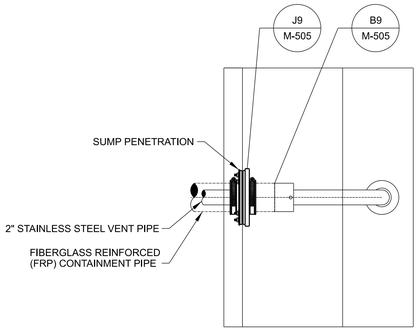


FRONT VIEW

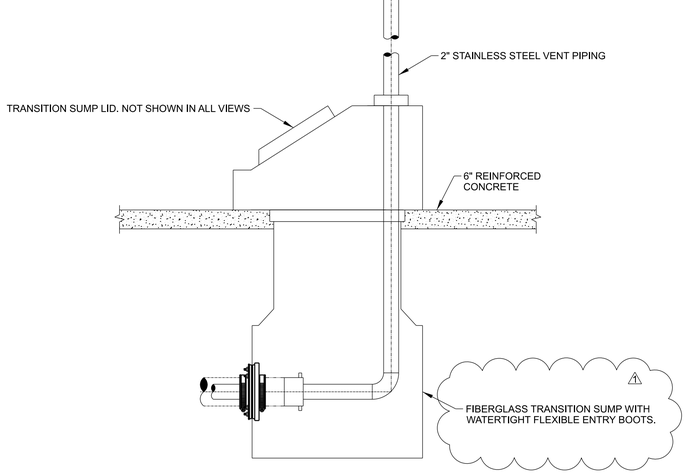
J1 TRANSITION SUMP AT BULK FUEL TANKS

SCALE: NOT TO SCALE

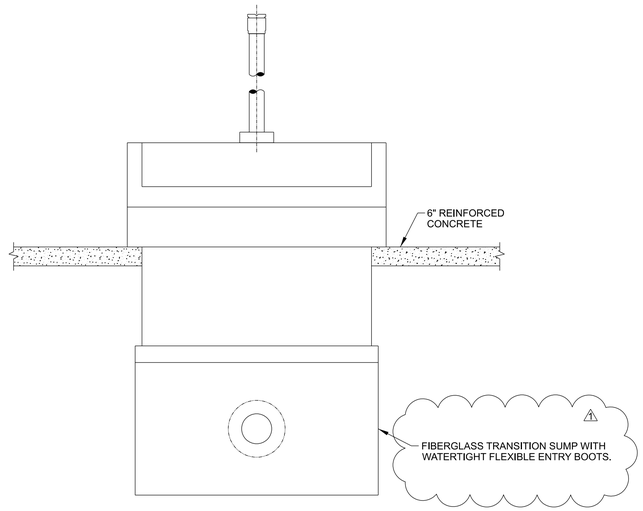
NOTES:
1. SEE DETAIL B1 ON SHEET M-505 FOR DOUBLE WALL PIPING DETAIL.
2. SEE DETAIL B9 AND J9 ON SHEET M-505 FOR SUMP PENETRATION DETAILS.
3. ALL VENT PIPING SHALL TERMINATE 12'-0" ABOVE GRADE.
4. VENT PIPING SHALL BE SUPPORTED WITH A UNISTRUT VENT RACK THAT HAS A CONCRETE BASE AND EXTENDS BELOW FROST DEPTH.



TOP VIEW



SIDE VIEW



FRONT VIEW

B1 TRANSITION SUMP AT OPERATIONAL FUEL TANKS

SCALE: NOT TO SCALE

NOTES:
1. SEE DETAIL B1 ON SHEET M-505 FOR DOUBLE WALL PIPING DETAIL.
2. SEE DETAIL B9 AND J9 ON SHEET M-505 FOR SUMP PENETRATION DETAILS.
3. ALL VENT PIPING SHALL TERMINATE 12'-0" ABOVE GRADE.
4. VENT PIPING SHALL BE SUPPORTED WITH A UNISTRUT VENT RACK THAT HAS A CONCRETE BASE AND EXTENDS BELOW FROST DEPTH.

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DESIGNED BY: M. PETERSON
DRAWN BY: M. PETERSON
CHECKED BY: D. SCHEUFFELE
SUBMITTED BY: D. SCHEUFFELE
SIZE: ANSI D
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SOLICITATION NO.: W9128F25RA043
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FILE NAME: BUCO00102M-505.dwg

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MECHANICAL FUELING DETAILS
SHEET 8 OF 9

SHEET ID
M-508

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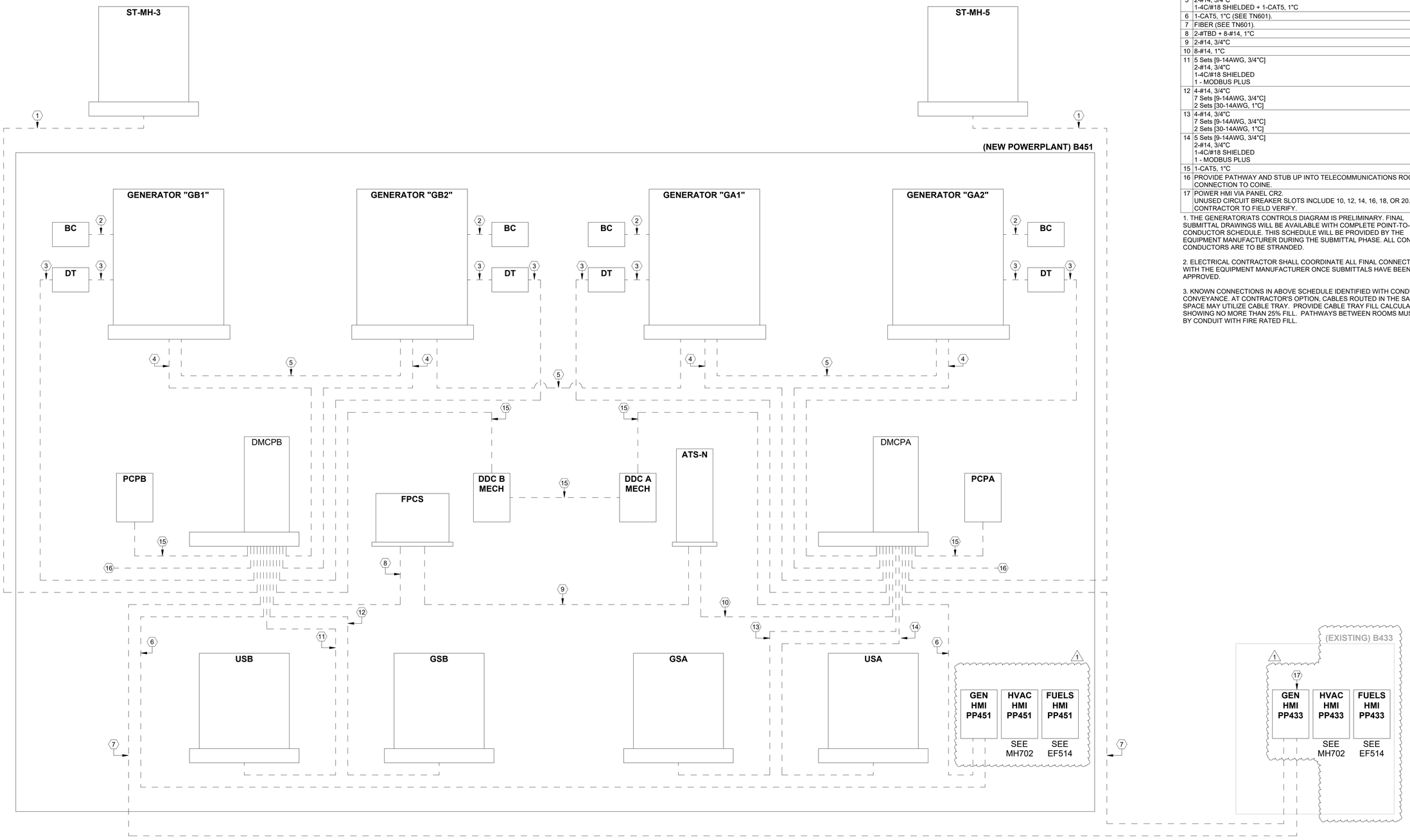

A1 GENERATOR CONTROLS DIAGRAM
SCALE: NTS

#	KEYNOTE - GENERATOR CONTROLS WIRING/CONDUIT
1	2 SETS [TBD 2"C]
2	2-#14, 3/4"C
3	2-#14, 3/4"C
4	18-#14, 1"C 2-#14, 3/4"C 1-4C/18 SHIELDED 4-#14, 3/4"C
5	2-#14, 3/4"C 1-4C/#18 SHIELDED + 1-CAT5, 1"C
6	1-CAT5, 1"C (SEE TN601).
7	FIBER (SEE TN601).
8	2-#TBD + 8-#14, 1"C
9	2-#14, 3/4"C
10	8-#14, 1"C
11	5 Sets [9-14AWG, 3/4"C] 2-#14, 3/4"C 1-4C/#18 SHIELDED 1 - MODBUS PLUS
12	4-#14, 3/4"C 7 Sets [9-14AWG, 3/4"C] 2 Sets [30-14AWG, 1"C]
13	4-#14, 3/4"C 7 Sets [9-14AWG, 3/4"C] 2 Sets [30-14AWG, 1"C]
14	5 Sets [9-14AWG, 3/4"C] 2-#14, 3/4"C 1-4C/#18 SHIELDED 1 - MODBUS PLUS
15	1-CAT5, 1"C
16	PROVIDE PATHWAY AND STUB UP INTO TELECOMMUNICATIONS ROOM FOR CONNECTION TO COINE.
17	POWER HMI VIA PANEL CR2. UNUSED CIRCUIT BREAKER SLOTS INCLUDE 10, 12, 14, 16, 18, OR 20. CONTRACTOR TO FIELD VERIFY.

1. THE GENERATOR/ATS CONTROLS DIAGRAM IS PRELIMINARY. FINAL SUBMITTAL DRAWINGS WILL BE AVAILABLE WITH COMPLETE POINT-TO-POINT CONDUCTOR SCHEDULE. THIS SCHEDULE WILL BE PROVIDED BY THE EQUIPMENT MANUFACTURER DURING THE SUBMITTAL PHASE. ALL CONTROLS CONDUCTORS ARE TO BE STRANDED.

2. ELECTRICAL CONTRACTOR SHALL COORDINATE ALL FINAL CONNECTIONS WITH THE EQUIPMENT MANUFACTURER ONCE SUBMITTALS HAVE BEEN APPROVED.

3. KNOWN CONNECTIONS IN ABOVE SCHEDULE IDENTIFIED WITH CONDUIT CONVEYANCE. AT CONTRACTOR'S OPTION, CABLES ROUTED IN THE SAME SPACE MAY UTILIZE CABLE TRAY. PROVIDE CABLE TRAY FILL CALCULATIONS SHOWING NO MORE THAN 25% FILL. PATHWAYS BETWEEN ROOMS MUST BE BY CONDUIT WITH FIRE RATED FILL.

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MARK	DESCRIPTION	DATE
1	AM #0004 - GENERAL REVISIONS	10/07/2025

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SOLICITATION NO.: W9128F25RA043
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DESIGNED BY: E.MCNAMARA
DRAWN BY: E.MCNAMARA
CHECKED BY: B.ADKINS
SUBMITTED BY: J.MOSTELLER
SIZE: ANSI D
FILE NAME: BUCC00102_DM_ME.rvt

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GENERATOR CONTROLS

SHEET ID

EP501

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GENERAL NOTES - EP600-EP609 SHEETS

1	FAULT CURRENT WITHSTAND AND INTERRUPTING CAPACITIES ARE MINIMUM. IF STANDARD RATINGS ARE GREATER, PROVIDE STANDARD RATING.
2	PROVIDE FULL LENGTH 100%-RATED NEUTRAL BAR AND A GROUNDING BAR IN EACH SECTION OF THE SWITCHBOARDS AND PANELBOARDS, UNLESS NEUTRAL IS INDICATED TO BE GREATER THAN THIS VALUE. PROVIDE MAIN BONDING JUMPER IN ACCORDANCE WITH NFPA 70 ARTICLE 250.
3	CONTRACTOR TO COORDINATE GENERATORS PARALLELING GEAR, MAIN SWITCHGEAR AND ATS CONTROLS CONNECTIONS AND REQUIREMENTS WITH EQUIPMENT VENDOR. IT IS THE RESPONSIBILITY OF THE PROVIDER OF ALL EQUIPMENT PROVIDED FOR THE INSTALLED CONDITION TO RESULT IN A FULL AND COMPLETE PARALLELING SYSTEM.
4	NOT ALL CIRCUITS ARE SHOWN ON ONE-LINE DIAGRAM. SEE PANEL SCHEDULES, MECHANICAL EQUIPMENT ELECTRICAL CONNECTION SCHEDULE, AND LIGHTING AND POWER PLANS FOR ADDITIONAL INFORMATION. ONE-LINE DIAGRAM IS INTENDED TO DEPICT CONNECTIONS BETWEEN MAJOR DISTRIBUTION COMPONENTS, AND TO PROVIDE INFORMATION WHERE NOT INDICATED ELSEWHERE.
5	PROVIDE CABLE REDUCING ADAPTERS AS NECESSARY TO ACCOMMODATE CONDUCTORS INCREASED IN SIZE TO MITIGATE VOLTAGE DROP. CONTRACTOR TO PROVIDE ADAPTER KIT TO DOWNSIZE THE CONDUCTORS PRIOR TO ENTERING THE PANEL AND CONNECTING THE LUGS OR CONTRACTOR CAN CHOOSE TO USE A BIGGER PANEL FRAME.
6	SEE POWER PLANS (EP100 AND EP400 SERIES), DRY-TYPE TRANSFORMER SCHEDULE (EP600), MECHANICAL EQUIPMENT ELECTRICAL CONNECTION SCHEDULE (EP610-EP619), AND PANEL SCHEDULES (EP620-EP659) FOR EQUIPMENT NEMA ENCLOSURE RATINGS NOT LISTED ON ONE-LINE DIAGRAM.
7	NOT ALL INFORMATION SHOWN ON THIS DIAGRAM (SPARE CIRCUIT BREAKERS, LOCKABLE BREAKERS, GFCI BREAKERS, MCB TRIP RATINGS, ETC.). REFERENCE PANEL SCHEDULES FOR ADDITIONAL INFORMATION.
8	CONDUIT SEALOFFS NOT IDENTIFIED ON THIS DIAGRAM. PROVIDE CONDUIT SEALOFFS WHERE REQUIRED IN HAZARDOUS AREAS BY NFPA 70. COORDINATE WITH SHEET E-101.
9	FAULT CURRENTS LISTED ASSUME 9,000A AVAILABLE FAULT CURRENT AT THE POINT OF CONNECTION TO ST-MH-3 AND ST-MH-5. CONTRACTOR TO COORDINATE AVAILABLE FAULT CURRENT WITH BASE UTILITY PROVIDER FOR USE WITH 26 05 73 POWER SYSTEM STUDIES. CONTRACTOR SHALL ADJUST EQUIPMENT SHORT CIRCUIT RATINGS ACCORDING TO STUDY RESULTS, BUT SHALL NOT BE LESS THAN THE MINIMUM VALUES STATED IN THE PLANS AND SPECIFICATIONS.
10	REFERENCE SHEET EP620 FOR CIRCUIT NOTES, HEADING DEFINITIONS, INSTRUCTIONS AND ADDITIONAL NOTES.
11	UPON 10 MONTHS POST-COMPLETION OF PROJECT, ELECTRICAL CONTRACTOR MUST PERFORM INFRARED TESTING OF ALL CONNECTIONS OF EQUIPMENT SHOWN. ELECTRICAL CONTRACTOR SHALL RE-TORQUE ANY LOOSE CONNECTIONS FOUND.
12	PROVIDE A MINIMUM 25% SPARE CONDUIT QUANTITY WITH MEDIUM VOLTAGE LINES THAT EXTEND OUTSIDE OF THE BUILDING FOOTPRINT AND POWER LINES OF ANY VOLTAGE WHICH TRAVERSE UNDERGROUND TO THE FILTER SHELTER.

(#) KEYNOTES - EP600 SHEETS

1	EXISTING 4.160KV TRANSFORMER TO BE REPLACED WITH THIS TRANSFORMER. SEE ES AND UD SERIES SHEETS FOR MORE DETAILS. SEE EP600 FOR TRANSFORMER DETAILS.
2	EXISTING SWITCH AND CONNECTIONS TO BE REMOVED DURING PHASING AND RECONNECTING OF POWER TO B442. SEE ES AND UD SERIES SHEETS FOR MORE DETAILS.
3	POWER METER. SEE POINTS ON SHEET MH702.
4	PROTECTIVE RELAY. SEE SPECIFICATION 26 13 13 FOR FURTHER DETAILS.
5	COMBINATION OF NEW CONDUIT AND EXISTING PATHWAYS. SEE ES AND UD SERIES SHEETS FOR MORE DETAILS.
6	INSTALL FEEDERS IN ACCORDANCE WITH NFPA 70 §695.6(A) FROM SWITCHGEAR THROUGH TO EFP-1.
7	REMOTE OPERABLE MOTORIZED BREAKER. SEE SPECIFICATIONS FOR DETAILS.
8	THE COMBINATION FIRE PUMP CONTROLLER/TRANSFER SWITCH SIZE IDENTIFIED ON THE CONTRACT DRAWINGS IS BASED ON PRELIMMINARY CALCULATIONS. SIZE THE COMBINATION FIRE PUMP CONTROLLER/TRANSFER SWITCH TO MATCH THE FIRE PUMP SIZE YIELDED BY THE PERFORMANCE REQUIREMENTS OF THIS CONTRACT'S PLANS AND SPECIFICATIONS. PROVIDE FIRE PUMP SYSTEM IDENTIFICATION PER NFPA 70 ARTICLE 695.
9	LOAD BANK AND LOAD BANK CONDUCTORS AND PATHWAY PROVIDED AS PART OF "LOAD BANK" CLIN. CONCRETE HOUSEKEEPING PAD TO BE PART OF CLIN "ALL OTHER SITE WORK." CAP STUB-UPS IF LOAD BANK EQUIPMENT OPTION IS NOT AWARDED WITH A MECHANICAL PLUG.
10	MTS TO BE PROVIDED WITH RELAY OUTPUT TO PUMP CONTROL PANEL. SEE SPECIFICATIONS AND EF SERIES SHEETS FOR DETAILS.
11	TWO 4" CONDUIT SHALL BE INSTALLED UNDERGROUND TO THE EXTERIOR OF THE BUILDING. CONDUIT SHALL BE INSTALLED WITH PULLWIRE. REFER TO ELECTRICAL SITE SHEETS FOR ADDITIONAL INFORMATION.
12	PROVIDE RED LOCK-ON TYPE CIRCUIT BREAKER.
13	PROVIDE A LABEL WITH THE FOLLOWING INSCRIPTION: "FIRE PROTECTION/LIFE SAFETY EQUIPMENT". CONSTRUCT AND FASTEN THE LABEL IDENTICAL TO THE EQUIPMENT NAMEPLATE, EXCEPT THE LABEL MUST BE RED LAMINATED PLASTIC WITH WHITE CENTER CORE.
14/1	MANHOLE PROVIDED BY CONCURRENT CONSTRUCTION PROJECT "ERCIP ENERGY RESILIENCE: CONSTRUCT REDUNDANT SURVEILLANCE REDUNDANT ELECTRICAL SUPPLY " (SOLICITATION NO. W9128F24R0066). CONTRACTOR TO COORDINATE DE-ENERGIZATION OF PRIMARY FEEDERS TO PROCEED WITH DISCONNECTION OF LOOP WITHIN MANHOLE, INSTALLATION OF ELECTRICAL SWITCH ON MANHOLE, AND TERMINATION OF THE EXISTING FEEDERS AND THE NEW FEEDERS INTO THE SWITCH COMPARTMENTS IDENTIFIED ON THE ONE-LINE DIAGRAM, TEST, AND RE-ENERGIZE. ENERGIZATION OF THE POWERPLANT SHALL NOT OCCUR UNTIL THE XCEL BUILDER CALL LINE AGREEMENT (CLIN "Entire work complete for Xcel Energy capacity increase and other associated fees." (THIS CONTRACT)) IS EXECUTED TO INCREASE THE CAPACITY FROM THE EXISTING STATE TO THAT SUFFICIENT TO SUPPORT B442 AND THE POWERPLANT STATION SERVICE.
E	SEE ENCLOSED CIRCUIT BREAKER SCHEDULE ON SHEET EP600 FOR PROPERTIES.
MG	BOND GROUND CONDUCTORS TO MANHOLE GROUND LOOP/ELECTRODE SYSTEM. PROVIDE GROUND ROD IN MANHOLE. SEE MANHOLE DETAIL(S).
OH	FEEDER SHALL BE ROUTED OVERHEAD IN CABLE TRAY.
P	SEE PANEL/SWITCHBOARD SCHEDULE FOR PROPERTIES.
T	SEE TRANSFORMER SCHEDULES ON SHEET EP600 FOR PROPERTIES.
UG	FEEDER SHALL BE ROUTED UNDERGROUND. COORDINATE CONDUIT INSTALLATION WITH STRUCTURAL FOUNDATION CONSTRUCTION TO ENSURE HORIZONTAL PORTIONS OF CONDUIT ARE INSTALLED BELOW FOOTING DEPTHS PRIOR TO POURING.
ZG	STANDALONE CABINET MAY BE OMITTED IF A COMBINATION MANUAL TRANSFER SWITCH WITH CAMLOCK CONNECTION CABINET IS PROVIDED. SEE DETAIL B2/ES505.
ZH/2	PROVISIONS (SUCH AS HEATERS) FOR COLD TEMPERATURES MAY BE REQUIRED, COMPLY WITH MANUFACTURER OPERATING TEMPERATURE REQUIREMENTS. COORDINATE WITH SUPPLING MANUFACTURER REGARDING EQUIPMENT CAPABILITIES AND PROVIDE HEATED ENCLOSURES OR SIMILAR REMEDIES SHOULD SUCH BE NEEDED TO SATISFY MANUFACTURER REQUIREMENTS. SEE SCHEDULE "14 WS / AFCCC / EWD LOCAL MEAN COINCIDENT (AVERAGE) DRY-BULB TEMPERATURES (1989-2018 BUCKLEY AFB, CO) " ON SHEET E-101 FOR EXTREME TEMPERATURES.

ENCLOSED CIRCUIT BREAKER SCHEDULE

TAG	LOCATION	SUPPLY FROM	VOLTS	EQUIPMENT PROPERTIES							DOWNSTREAM CIRCUIT PROPERTIES					REMARKS
				ENCLOSURE	FAULT DUTY (MIN.)	EQPT FRAME	CB RATING	CKT NOTES	METER	CB SVC	SSCB	ATZ	NLL	CCC	MCIT	CIRCUIT	
ECB QLA2	DISTRO A 112	112 XFMR QTA2	208 V	NEMA 1	10kA	250 A	250 A	--	No	Std	Yes	3	No	3	75	4-350KCMIL, #2 G, 3"C	--
ECB QLB2	DISTRO B 120	120 XFMR QTB2	208 V	NEMA 1	10kA	250 A	250 A	--	No	Std	Yes	3	No	3	75	4-350KCMIL, #2 G, 3"C	--
ECB FBC-1	FORKLIFT CHARGING 121	QHB1	480 V	NEMA 7	22kA	60 A	60 A	--	No	Std	Yes	2	Yes	3	--	--	ENCLOSED CIRCUIT BREAKER SERVES AS PROVISION FOR FUTURE GOVERNMENT-FURNISHED CHARGING EQUIPMENT.
ECB LP-1	NEW OIL STORAGE 122	QHB2	480 V	NEMA 1	22kA	60 A	15 A	B	No	Std	No	3	No	3	75	3-#12, #12 G, 3/4"C	--
ECB LP-2	NEW OIL STORAGE 122	QHB2	480 V	NEMA 1	22kA	60 A	15 A	B	No	Std	No	3	No	3	75	3-#12, #12 G, 3/4"C	--
ECB SF-B1	MECHANICAL MEZ. GEN RM B 202	QHB1	480 V	NEMA 1	22kA	100 A	90 A	B	No	Std	No	3	Yes	3	75	3-#6, #8 G, 1"C	--
ECB SF-B2	MECHANICAL MEZ. GEN RM B 202	QHB1	480 V	NEMA 1	22kA	100 A	90 A	B	No	Std	No	3	Yes	3	75	3-#6, #8 G, 1"C	--
ECB IP-F2	FILTER SHELTER	FILTER SHELTER ATS-PB	480 V	NEMA 3R	14kA	60 A	20 A	B,L	No	Std	Yes	2	No	3	75	3-#12, #12 G, 3/4"C	--
ECB IP-F3	FILTER SHELTER	FILTER SHELTER ATS-PA	480 V	NEMA 3R	14kA	60 A	20 A	B,L	No	Std	Yes	2	No	3	75	3-#12, #12 G, 3/4"C	--
ECB NLF	ELEC 104	104 XFMR NTF	208 V	NEMA 1	10kA	150 A	150 A	E,V	No	Std	Yes	3	Yes	5	75	3-250KCMIL, 2-250KCMIL N, #2 G, 3"C	--

ENCLOSED CIRCUIT BREAKER NOTES
1. WHERE NEUTRAL CONDUCTOR IS PROVIDED, THE NEUTRAL SHALL BE SWITCHED.

TRANSFORMER SCHEDULE GENERAL NOTES

1	CONTRACTOR MUST SIZE THE TRANSFORMER OVERCURRENT PROTECTION (INCLUDING DEVICE FRAME) PER SPECIFICATION 26 05 73 RECOMMENDATIONS AT NO ADDITIONAL COST TO THE GOVERNMENT.
2	BOND TRANSFORMER TO GROUNDING GRID WITH MINIMUM-SIZED GROUNDING ELECTRODE SHOWN IN SCHEDULE.
3	WHERE FEEDERS HAVE BEEN INCREASED IN SIZE TO ACCOUNT FOR VOLTAGE DROP AND/OR AMPACITY CORRECTION FACTORS TO THE DEGREE THAT THE FEEDERS ARE LARGER THAN THE EQUIPMENT TERMINALS, PROVIDE APPROPRIATELY-SIZED CABLE REDUCING ADAPTERS.
4	TRANSFORMER SCHEDULE DOES NOT INCLUDE DRIVE ISOLATION TRANSFORMERS.
5	ENCLOSURE RATINGS LISTED ARE MINIMUM RATINGS WITH RESPECT TO DUST AND LIQUID INGRESS.

MEDIUM- TO LOW-VOLTAGE OIL-FILLED TRANSFORMER SCHEDULE

TAG	SIZE (kVA)	LOCATION	PRIMARY						SECONDARY								MOUNTING LOCATION	ENCLOSURE RATING (MINIMUM)	REMARKS
			SYSTEM	AMPS	CIRCUIT	MCIT	CCC	ATZ	CKT NOTES	SYSTEM	AMPS	CIRCUIT	MCIT	CCC	NLL	ATZ	CKT NOTES	MIN. GND ELECTRODE	
FPTA	45	EXTERIOR	13200V	2 A	3-#2, #6 G, 4"C (15kV AL 133% INSULATION) (1) 4" SPARE CONDUIT	MV-105	3	2	F,P	480Y/277V	54 A	4-#4, 1-1/2"C (1) 1-1/2" SPARE CONDUIT	75	3	No	2	P	#4	GROUND/CONCRETE PAD	NEMA 3R	SEE SECTION 26 12 19.10 SUBMITTAL PHASING AND COORDINATION REQUIREMENT AS IT RELATES TO TRANSFORMER AND SUPPORTING INFRASTRUCTURE SIZING. PROVIDE A LABEL WITH THE FOLLOWING INSCRIPTION: "FIRE PROTECTION/LIFE SAFETY EQUIPMENT". CONSTRUCT AND FASTEN THE LABEL IDENTICAL TO THE EQUIPMENT NAMEPLATE, EXCEPT THE LABEL MUST BE RED LAMINATED PLASTIC WITH WHITE CENTER CORE.
FPTB	45	EXTERIOR	13200V	2 A	3-#2, #6 G, 4"C (15kV AL 133% INSULATION) (1) 4" SPARE CONDUIT	MV-105	3	2	F,P	480Y/277V	54 A	4-#4, 1-1/2"C (1) 1-1/2" SPARE CONDUIT	75	3	No	2	P	#4	GROUND/CONCRETE PAD	NEMA 3R	SEE SECTION 26 12 19.10 SUBMITTAL PHASING AND COORDINATION REQUIREMENT AS IT RELATES TO TRANSFORMER AND SUPPORTING INFRASTRUCTURE SIZING. PROVIDE A LABEL WITH THE FOLLOWING INSCRIPTION: "FIRE PROTECTION/LIFE SAFETY EQUIPMENT". CONSTRUCT AND FASTEN THE LABEL IDENTICAL TO THE EQUIPMENT NAMEPLATE, EXCEPT THE LABEL MUST BE RED LAMINATED PLASTIC WITH WHITE CENTER CORE.
OTM	30	OFFLOAD	13200V	1 A	3-#2, #6 G, 4"C (15kV AL 133% INSULATION) (1) 4" SPARE CONDUIT	MV-105	3	2	P	480Y/277V	36 A	4-1/0, 1-1/2"C (1) 1-1/2" SPARE CONDUIT	75	3	No	2	P	#6	GROUND/CONCRETE PAD	NEMA 3R	PROVIDE POWER METER AT TRANSFORMER.
T442A(TECH)	1500	B442 EXTERIOR	13200V	66 A	3-4/0, #1 G, 4"C (15kV AL 133% INSULATION) (1) 4" SPARE CONDUIT	MV-105	3	2	P	480Y/277V	1803 A	RECONNECT EXISTING FEEDERS: SEE 26 13 13 ATTACHMENT AND FIELD VERIFY	--	--	--	2	P	3/0	GROUND/CONCRETE PAD	NEMA 3R	--
T442B(TECH)	1500	B442 EXTERIOR	13200V	66 A	3-4/0, #1 G, 4"C (15kV AL 133% INSULATION) (1) 4" SPARE CONDUIT	MV-105	3	2	P	480Y/277V	1803 A	RECONNECT EXISTING FEEDERS: SEE 26 13 13 ATTACHMENT AND FIELD VERIFY	--	--	--	2	P	3/0	GROUND/CONCRETE PAD	NEMA 3R	--
T442C(MECH)	1000	B442 EXTERIOR	13200V	44 A	3-4/0, #1 G, 4"C (15kV AL 133% INSULATION) (1) 4" SPARE CONDUIT	MV-105	3	2	P	480Y/277V	1202 A	RECONNECT EXISTING FEEDERS: SEE 26 13 13 ATTACHMENT AND FIELD VERIFY	--	--	--	2	P	3/0	GROUND/CONCRETE PAD	NEMA 3R	--
T442D(MECH)	1000	B442 EXTERIOR	13200V	44 A	3-4/0, #1 G, 4"C (15kV AL 133% INSULATION) (1) 4" SPARE CONDUIT	MV-105	3	2	P	480Y/277V	1202 A	RECONNECT EXISTING FEEDERS: SEE 26 13 13 ATTACHMENT AND FIELD VERIFY	--	--	--	2	P	3/0	GROUND/CONCRETE PAD	NEMA 3R	--

MEDIUM- TO LOW-VOLTAGE DRY-TYPE TRANSFORMER SCHEDULE

TAG	SIZE (kVA)	LOCATION	PRIMARY						SECONDARY								MOUNTING LOCATION	ENCLOSURE RATING (MINIMUM)	REMARKS
			SYSTEM	AMPS	CIRCUIT	MCIT	CCC	ATZ	CKT NOTES	SYSTEM	AMPS	CIRCUIT	MCIT	CCC	NLL	ATZ	CKT NOTES	MIN. GND ELECTRODE	
DTA	750	DISTRO A 112	13200V	33 A	3-4/0, #1 G, 4"C (15kV AL 133% INSULATION)	MV-105	3	0	--	480Y/277V	902 A	1200A BUSWAY (REFER TO 26 20 00; 4P+G)	90	4	Yes	0	--	4/0	FLOOR/CONCRETE PAD	NEMA 1	--
DTB	750	DISTRO B 120	13200V	33 A	3-4/0, #1 G, 4"C (15kV AL 133% INSULATION)	MV-105	3	0	--	480Y/277V	902 A	1200A BUSWAY (REFER TO 26 20 00; 4P+G)	90	4	Yes	0	--	4/0	FLOOR/CONCRETE PAD	NEMA 1	--

LOW- TO LOW-VOLTAGE DRY-TYPE TRANSFORMER SCHEDULE

TAG	SIZE (kVA)	LOCATION	SUPPLY FROM	PRIMARY		SECONDARY									MOUNTING LOCATION	ENCLOSURE RATING (MINIMUM)	HARMONIC TREATMENT	REMARKS
				SYSTEM	AMPS	SYSTEM	AMPS	CIRCUIT	MCIT	CCC	NLL	ATZ	CKT NOTES	MIN. GND ELECTRODE	SYS. BOND. JUMPER			
NT	45	ELEC 104	NH	480V	54 A	208Y/120V	125 A	3-3/0, 500KCMIL N, #4 SSBJ, 3"C	75	4	Yes	0	--	#4	#4	FLOOR/CONCRETE PAD	NEMA 1	K-13	--
NTF	45	ELEC 104	NH	480V	54 A	208Y/120V	125 A	3-250KCMIL, 2-250KCMIL N, #2 SSBJ, 3"C	75	5	Yes	0	V	#2	#2	WALL/ELEVATED	NEMA 1	K-4	PROVIDE A LABEL WITH THE FOLLOWING INSCRIPTION: "FIRE PROTECTION/LIFE SAFETY EQUIPMENT". CONSTRUCT AND FASTEN THE LABEL IDENTICAL TO THE EQUIPMENT NAMEPLATE, EXCEPT THE LABEL MUST BE RED LAMINATED PLASTIC WITH WHITE CENTER CORE.
OTL	15	OFFLOAD	OH	480V	18 A	208Y/120V	42 A	4-#4, #8 SSBJ, 1"C	75	3	No	2	P	#6	#6	GROUND/CONCRETE PAD	NEMA 3R	K-1	--
PT	15	FILTER SHELTER	PH	480V	18 A	208Y/120V	42 A	4-#6, #8 SSBJ, 1-1/4"C	75	3	No	2	--	#6	#6	GROUND/CONCRETE PAD	NEMA 3R	K-1	--
PTA	15	FILTER SHELTER	PHA	480V	18 A	208Y/120V	42 A	4-#6, #8 SSBJ, 1-1/4"C	75	3	No	2	--	#6	#6	GROUND/CONCRETE PAD	NEMA 3R	K-1	--
PTB	15	FILTER SHELTER	PHB	480V	18 A	208Y/120V	42 A	4-#6, #8 SSBJ, 1-1/4"C	75	3	No	2	--	#6	#6	GROUND/CONCRETE PAD	NEMA 3R	K-1	--
QTA1	45	DISTRO A 112	QHA1	480V	54 A	208Y/120V	125 A	4-1/0, #6 SSBJ, 2"C	75	3	No	0	--	#6	#6	WALL/ELEVATED	NEMA 1	K-1	--
QTA2	75	DISTRO A 112	QHA2	480V	90 A	208Y/120V	208 A	4-250KCMIL, #2 SSBJ, 3"C	75	3	No	0	--	#2	#2	FLOOR/CONCRETE PAD	NEMA 1	K-1	--
QTB1	45	DISTRO B 120	QHB1	480V	54 A	208Y/120V	125 A	4-1/0, #6 SSBJ, 2"C	75	3	No	0	--	#6	#6	WALL/ELEVATED	NEMA 1	K-1	--
QTB2	75	DISTRO B 120	QHB2	480V	90 A	208Y/120V	208 A	4-250KCMIL, #2 SSBJ, 3"C	75	3	No	0	--	#2	#2	FLOOR/CONCRETE PAD	NEMA 1	K-1	--

FOR GENERAL NOTES, AND KEYNOTES, SEE SHEET EP600. SEE EP501 FOR GENERATOR CONTROLS DIAGRAM.

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NO	MARK	DESCRIPTION	DATE
2	AM #0004	GENERAL REVISIONS	10/07/2025
1	AM #0002	GENERAL REVISIONS	09/19/2025

ISSUE DATE: 05/01/2025
SOLICITATION NO.: W9128F25RA043
CONTRACT NO.:

DESIGNED BY: E.MCNAMARA
DRAWN BY: E.MCNAMARA
CHECKED BY: B.ADKINS
SUBMITTED BY: S.JACOBSEN
SIZE: ANSI D
FILE NAME: BUCO00102_DM_ME.rvt

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVE.
OMAHA, NE 68102

BUCKLEY SFB, COLORADO
POWER INDEPENDENCE: MISSION CONTROL STATION

ELECTRICAL ONE-LINE DIAGRAM NOTES AND SCHEDULES

SHEET ID
EP600

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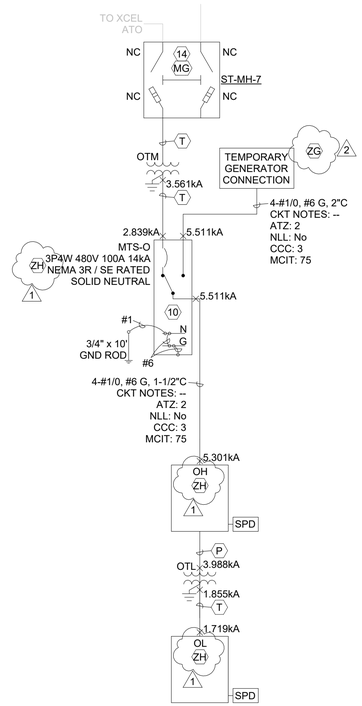

F15 ONE-LINE DIAGRAM: OFFLOAD

SCALE: NTS

FOR TRANSFORMER SCHEDULES, GENERAL NOTES, AND KEYNOTES, SEE SHEET EP600.

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MARK	DESCRIPTION	DATE
2	AM #0004 - GENERAL REVISIONS	10/07/2025
1	AM #0002 - GENERAL REVISIONS	09/19/2025

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ISSUE DATE: 05/01/2025
SOLICITATION NO.: W9128F25RA043
CONTRACT NO.:

DESIGNED BY: E.MCNAMARA
DRAWN BY: E.MCNAMARA
CHECKED BY: B.ADKINS
SUBMITTED BY: J.MORTEN
SIZE: ANSI D
FILE NAME: BUCC000102_DM_ME.rvt

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ONE-LINE DIAGRAM OFFLOAD

SHEET ID

EP603

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SUPPLEMENTAL SPECIAL SYSTEMS LEGEND

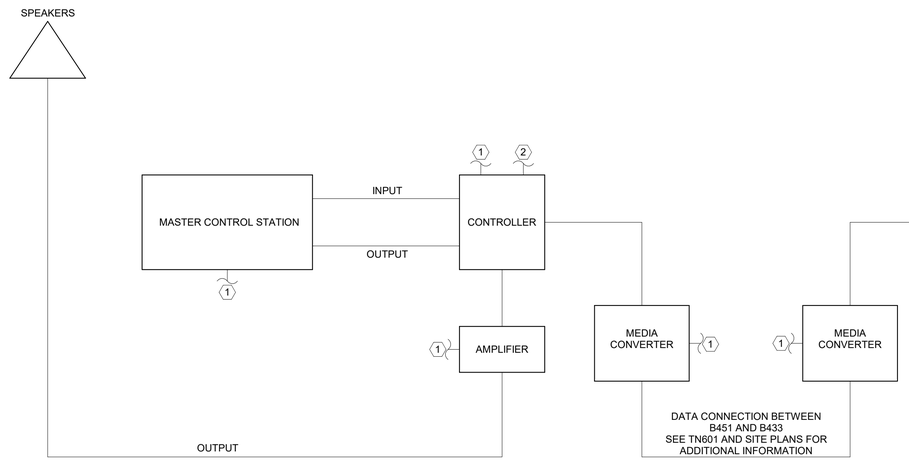
IMS	INTERCOM MASTER STATION
AV S	INTERCOM CEILING MOUNTED SPEAKER
GC	GATE CONTROLLER
IMS	INTERCOM MASTER STATION

GENERAL NOTES - EY SERIES SHEETS

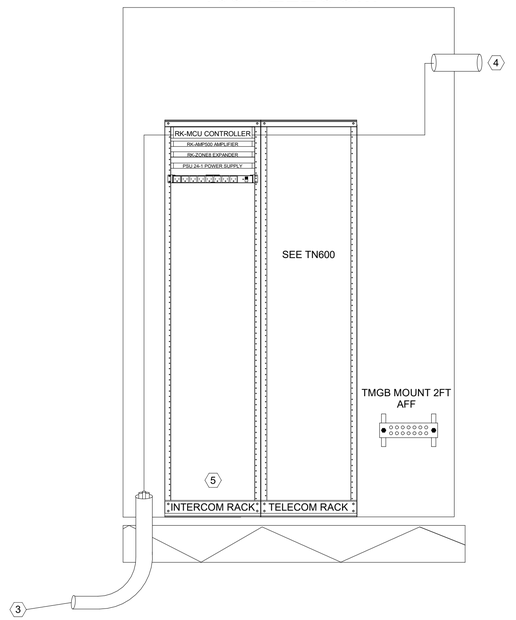
A	COORDINATE RECESS MOUNTING OF CONDUIT, BACKBOXES, DEVICES, AND EQUIPMENT WITH OTHER TRADES. DEVICES AND EQUIPMENT LOCATED AT PRECAST AND OTHER CONCRETE WALLS HAVE BEEN SPECIFICALLY IDENTIFIED FOR COORDINATION.
B	CONCRETE, CONCRETE, AND CONCRETE BLOCK WALLS SHALL BE SURFACE MOUNTED. JUNCTION BOXES, DEVICES, BACKBOXES, ASSOCIATED CONDUIT, ETC., SHALL BE RECESS MOUNTED ON GYPSUM WALLS. COORDINATE WITH ARCHITECTURAL SHEETS.
C	EACH PULL ROPE SHALL BE LABELED WITH A UNIQUE IDENTIFIER TAGGED ON EACH END. THE USER END OF THE PULL ROPE SHALL ALSO INDICATE THE SOURCE LOCATION AND VICE VERSA.
D	PENETRATION OPENINGS THROUGH AIR BARRIERS SHALL COMPLY WITH THE BUILDING AIR BARRIER REQUIREMENTS. CORRECT ALL PENETRATIONS THAT ARE DETERMINED DEFICIENT DURING TESTING. SEE ARCHITECTURAL SHEETS FOR AIR BARRIER TESTING BOUNDARIES. SEE ARCHITECTURE FOR SEALING PENETRATIONS.
E	DO NOT PENETRATE STRUCTURAL COLUMNS. AFIX DEVICES AND RACEWAY WITH NON-PENETRATING BEAM C-CLAMPS, BRACKETS, CLIPS, AND UNISTRUT.
F	ALL INTERCOMMUNICATIONS CABLING SHALL BE HOUSED IN PROTECTIVE CONDUIT.
G	RISER IS TYPICAL ONLY. SEE FLOOR PLANS FOR EXACT NUMBER AND LOCATIONS OF OUTLETS, RACKS, AND CABLE TRAY.
H	GROUND TTB's RACKS, CABLE TRAYS, ETC., PER ANSI/TIA/EIA 607A.
I	SEE TN600 FOR ADDITIONAL REQUIRMENTS.

(#) KEYNOTES - EY SERIES SHEETS

1	CONNECT TO 120 VAC, 20 AMP DEDICATED POWER CIRCUIT FROM FIRE ALARM POWER PANEL. TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS) IS TO BE PROVIDED ON PANELS SERVING FIRE ALARM CIRCUITS. SEE ELECTRICAL (EP) SHEETS FOR POWER PANEL AND LOCATION.
2	INTERFACE FROM FACP TO MUTE AUDIBLE DISTRIBUTION OF INTERCOM SYSTEM DURING FIRE ALARM EVACUATION NOTIFICATION.
3	4" SCHEDULE 40 CONDUIT WITH 3-CELL MESH INNER DUCTS FROM NEW HAND HOLE. STUBBED UP 3" AFF. USE (1) 1 1/4" INNER DUCT TO RUN 24-STRAND SINGLE-MODE FIBER OPTIC OUTSIDE PLANT SERVICE ENTRANCE CABLE. USE SECOND INNER DUCT TO INSTALL 25-PAIR #24 AWG OUTSIDE PLANT VOICE SERVICE ENTRANCE CABLE.
4	PROVIDE CONDUITS SIZED FOR THE NUMBER OF CABLES IDENTIFIED IN TN001 GENERAL NOTES. OUTSIDE OF THE TELECOM ROOM, ALL COMMUINICATIONS MEDIA SHALL BE ROUTED USING CONDUIT OR TUBING AS APPLICABLE FOR THE LEVEL OF PHYSICAL DAMAGE TO WHICH THE RACEWAY IS SUBJECT (SEE E-120).
5	DEDICATED RECEPTACLES. SEE ELECTRICAL SHEETS FOR ADDITIONAL INFORMATION.



F1 INTERCOMMUNICATIONS ONE-LINE DIAGRAM
SCALE: NTS



A13 INTERCOMMUNICATIONS RISER DIAGRAM
SCALE: NTS

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MARK	DESCRIPTION	DATE
1	AM #0004 - GENERAL REVISIONS	10/07/2025

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Plot Date: 10/2/2025 9:24:37 AM

DESIGNED BY: S.BLASER
DRAWN BY: S.BLASER
CHECKED BY: J.COOK
SUBMITTED BY: S.LINDGREN
SIZE: ANSI D
ISSUE DATE: 05/01/2025
SOLICITATION NO.: W9128F25RA043
CONTRACT NO.:
FILE NAME: BUCO00102_DM_ME.rvt

US ARMY CORPS OF ENGINEERS
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INTERCOMMUNICATIONS DETAILS AND NOTES
SUPPLEMENTAL LEGEND

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