Construction Document Submission - Specifications

for the proposed new facility at

Ohio Department of Transportation
District 8
Preble County
Full-Service Maintenance Facility

Volume 02
Divisions 21 - 41
October 17, 2025

BURGESS & NIPLE KZF DESIGN joint venture

PROCUREMENT AND CONTRACTING REQUIREMENTS GROUP

Division 00 – Procurement and Contracting Requirements

Introductory Information
00 01 10.....Table of Contents

Procurement Requirements
00 10 00.....Solicitation
00 21 13.....Instructions to Bidders
00 31 13.....Preliminary Schedules
00 31 19.....Existing Condition Information
00 31 21.....Survey Information
00 31 24.....Environmental Assessment Information
00 31 26.....Existing Hazardous Material Information
00 31 32.....Geotechnical Data

00 41 13.....Bid Form
00 43 13.....Bid Security Form
00 45 13.....Bidder's Qualifications
00 45 39.....EDGE Affidavit

Contracting Requirements
00 52 00.....Agreement Form
00 52 14.....Subcontract Form (OAC 153:1-03-02)
00 61 13.....Performance and Payment Bond Form
00 61 13.19.....Acknowledgement of Surety

00 71 00.....Contracting Definitions
00 72 13.....General Conditions
00 73 00.....Supplementary Conditions

00 73 43.....Wage Rate Requirements

SPECIFICATIONS GROUP

GENERAL REQUIREMENTS SUBGROUP

Division 01 – General Requirements

01 10 00.....Summary
01 23 00.....Alternates
01 25 00.....Substitution Procedures
01 29 00.....Payment Procedures
01 31 00.....Project Management and Coordination
01 32 00.....Construction Progress Documentation
01 32 16.....Construction Progress Schedule
01 33 00.....Submittal Procedures
01 40 00.....Quality Requirements
01 42 00.....References
01 43 39.....Mockups
01 50 00.....Temporary Facilities and Controls
01 57 23.....Temporary Storm Water Pollution Control
01 60 00.....Product Requirements
01 73 00.....Execution
01 74 19.....Construction Waste Management and Disposal
01 77 00.....Closeout Procedures

01 78 23 .....Operations and Maintenance Data
01 78 39 .....Project Record Documents
01 79 00 .....Demonstration and Training

FACILITY CONSTRUCTION SUBGROUP

Division 02 – Existing Conditions
02 41 16 .....Structure Demolition
02 70 00 .....Recycling of Universal Hazardous Waste
02 82 00 .....Asbestos Containing Material Abatement and Disposal
02 83 00 .....Lead, Cadmium, Chromium and Arsenic Coatings in Construction

Division 03 – Concrete
03 30 00 .....Cast-In-Place Concrete

Division 04 – Masonry
04 20 00 .....Unit Masonry

Division 05 – Metals
05 12 00 .....Structural Steel Framing
15 40 00 .....Cold-Formed Metal Framing

Division 06 – Wood, Plastics, and Composites
06 10 00 .....Rough Carpentry
06 16 00 .....Sheathing
06 41 16 .....Plastic Laminate Clad Cabinets
06 64 00 .....Plastic Paneling

Division 07 – Thermal and Moisture Control
07 21 00 .....Thermal Insulation
07 27 26 .....Fluid-Applied Membrane Air Barriers
07 41 13.16 .....Standing-Seam Metal Roof Panels
07 41 16 .....Insulated Metal Roof Panels
07 42 13.19 .....Insulated Metal Wall Panels
07 62 00 .....Sheet Metal Flashing and Trim
07 72 53 .....Snow Guards
07 84 13 .....Penetration Firestopping
07 92 00 .....Joint Sealant
07 92 19 .....Acoustical Joint Sealants

Division 08 – Openings
08 11 13 .....Hollow Metal Doors and Frames
08 22 20 .....Fiberglass Reinforced Plastic (FRP) Doors and Frames
08 36 13 .....Sectional Doors
08 41 13 .....Aluminum-Framed Entrances and Storefronts
08 51 13 .....Aluminum Windows
08 56 53 .....Security Windows
08 71 00 .....Door Hardware
08 80 00 .....Glazing
08 88 53 .....Security Glazing

Division 09 – Finishes
09 21 16.23 .....Gypsum Board Shaft Wall Assemblies
09 22 16 .....Non-Structural Metal Framing
09 29 00 .....Gypsum Board
09 30 00 .....Tiling
09 51 23 .....Acoustical Tile Ceilings
09 65 13 .....Resilient Base and Accessories
09 67 23 .....Resinous Flooring
09 91 13 .....Exterior Painting
09 91 23 .....Interior Painting

Division 10 – Specialties

10 11 00.....Visual Display Units
10 14 23.16.....Room-Identification Panel Signage
10 21 13.19.....Plastic Toilet Compartments
10 28 00.....Toilet, Bath and Laundry Accessories
10 44 13.....Fire Protection Cabinets
10 44 16.....Fire Extinguishers
10 51 13.....Metal Lockers
10 75 16.....Ground-Set Flagpoles

Division 11 – Equipment

11 11 00.....Vehicle Service Equipment
11 11 19.20.....Interior Grease/Oil Piping Systems
11 30 13.....Residential Appliances
11 40 00.....Foodservice Equipment

Division 12 – Furnishings

12 21 13.....Horizontal Louver Blinds
12 32 16.....Manufactured Plastic-Laminate-Clad Casework
12 36 61.16.....Simulated Stone Countertops

Division 13 – Special Construction

13 31 23.....Tension Fabric Structures
13 34 19.....Metal Building Systems

Division 14 – Conveying Equipment

14 45 10.....Cranes

FACILITY SERVICES SUBGROUP

Division 21 – Fire Suppression

21 00 00.....Fire Suppression
21 05 09.....General Fire Suppression Piping Requirements
21 05 29.....Hangers and Supports for Fire-Suppression Piping and Equipment
21 05 53.02.....Identification for Fire-Suppression Piping and Equipment
21 13 00.01.....Fire Suppression Sprinkler Systems

Division 22 – Plumbing

22 05 00.....Common Work Results for Plumbing
22 05 05.....Plumbing Excavation and Backfill
22 05 08.....Plumbing Electrical Coordination
22 05 09.....General Plumbing Piping Requirements
22 05 10.....Plumbing Piping Expansion, Noise, and Vibration Isolation
22 05 23.....General-Duty Valves for Plumbing Piping
22 05 29.....Hangers and Supports for Plumbing Piping and Equipment
22 05 53.02.....Identification for Plumbing Piping and Equipment
22 05 54.....Plumbing Valve Tagging
22 07 19.....Plumbing Piping Insulation
22 11 16.....Domestic Water Piping
22 11 19.....Domestic Water Piping Specialties
22 11 24.....Facility Natural Gas Piping
22 13 13.....Facility Sanitary Sewers
22 13 16.....Sanitary Waste and Vent Piping
22 13 23.....Sanitary Waste Interceptors
22 15 13.....General-Service Compressed-Air Piping
22 15 19.....General-Service Packaged Air Compressors and Receivers
22 33 33.....Gas Fired Water Heater
22 42 00.....Commercial Plumbing Fixtures
22 45 00.....Emergency Plumbing Fixtures
22 47 00.....Drinking Fountains and Water Coolers

Division 23 – Heating, Ventilating, and Air Conditioning

23 05 00.....Common Work Results for HVAC
23 05 29.....Hangers and Supports for HVAC Piping and Equipment
23 05 48.13.....Vibration Controls for HVAC
23 05 53.....Identification for HVAC Piping and Equipment
23 05 93.....Testing, Adjusting, and Balancing for HVAC
23 07 13.....Duct Insulation
23 07 16.....HVAC Equipment Insulation
23 07 19.....HVAC Piping Insulation
23 23 00.....Refrigerant Piping
23 31 13.....Metal Ducts
23 33 00.....Air Duct Accessories
23 33 46.....Flexible Ducts
23 34 00.....HVAC Fans
23 37 13.13.....Air Diffusers
23 37 13.23.....Registers and Grilles
23 51 13.11.....Draft Control Fans
23 51 13.16.....Vent Dampers
23 51 16.....Fabricated Breechings and Accessories
23 54 16.13.....Gas-Fired Furnaces
23 55 23.13.....Low-Intensity, Gas-Fired, Radiant Heaters
23 62 00.....Packaged Compressor and Condenser Units
23 73 39.....Indoor, Direct-Fired Heating and Ventilating Units
23 81 26.....Split-System Air-Conditioners
23 82 39.19.....Wall and Ceiling Unit Heaters

Division 26 – Electrical

26 00 10.....Supplemental Requirements for Electrical
26 05 00.....Common Work Results for Electrical
26 05 11.....Equipment Hook-Up and Final Connection
26 05 19.....Low-Voltage Electrical Power Conductors and Cables
26 05 26.....Grounding and Bonding for Electrical Systems
26 05 29.....Hanger and Supports for Electrical Systems
26 05 33.13.....Conduits for Electrical Systems
26 05 33.16.....Boxes and Covers for Electrical Systems
26 05 43.....Underground Ducts and Raceways for Electrical Systems
26 05 48.....Vibration and Seismic Controls for Electrical Systems
26 05 53.....Identification for Electrical Systems
26 05 73.13.....Short-Circuit Studies
26 05 73.16.....Coordination Studies
26 05 73.19.....Arc-Flash Hazard Analysis
26 07 02.....Gas Detection Systems
26 09 23.....Lighting Control Devices
26 22 13.....Low-Voltage Distribution Transformers
26 24 13.....Switchboards
26 24 16.....Panelboards
26 27 26.....Wiring Devices
26 28 13.....Fuses
26 28 16.....Enclosed Switches and Circuit Breakers
26 31 13.16.....Gas-Engine-Driven Generator Sets
26 36 00.....Transfer Switches
26 43 13.....Surge Protective Devices for Low-Voltage Electrical Power Circuits
26 51 19.....LED Interior Lighting
26 52 13.....Emergency and Exit Lighting
26 56 19.....LED Exterior Lighting

Division 27 – Communications

27 11 00.....Communications Equipment Room Fittings
27 13 00.....Communications Backbone Cabling

27 15 00.....Communications Horizontal Cabling

Division 28 – Electronic Safety and Security
28 13 00.....Access Control Software and Database Management
28 23 00.....Video Surveillance System
28 46 21.11.....Addressable Fire-Alarm Systems

SITE AND INFRASTRUCTURE SUBGROUP

Division 31 – Earthwork
31 10 00.....Site Clearing
31 20 00.....Earth Moving

Division 32 – Exterior Improvements
32 12 16.....Asphalt Paving
32 13 13.....Concrete Paving
32 13 73.....Concrete Paving Joint Sealants
32 17 13.....Parking Bumpers
32 17 23.....Pavement Markings
32 17 26.....Tactile Warning Surfacing
32 31 13.....Chain Link Fences and Gates
32 92 00.....Turf and Grasses

Division 33 – Utilities
33 05 00.....Common Work Results for Utilities
33 14 15.....Site Water Distribution Piping
33 42 00.....Stormwater Conveyance
33 56 13.....Aboveground Fuel-Storage Tanks

PROCESS EQUIPMENT SUBGROUP

Division 41 – Material Processing and Handling Equipment
41 23 23.13.....Recessed Vertical Half-Scissor Vehicle Lift
41 23 23.16.....Mobile Column Vehicle Lift

END OF DOCUMENT

SECTION 21 00 00

FIRE SUPPRESSION

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide an approved and complete sprinkler system for all areas of the Truck Storage building, whether or not those areas are indicated on the Drawings. Per building codes, if truck storage area and office/maintenance is one building then the entire building must be sprinkled.

B. Furnish material, labor, tools, accessories, and equipment to complete and leave ready for operation all fire suppression systems of this Project as described in these Specifications and as shown on the Drawings.

C. It is the intent that the Fire Suppression Work be complete in every respect. Installation shall comply with the Latest Enforced Edition of all applicable Codes, Regulations, Rules and Standards (including all interim agreements in force) unless otherwise noted.

D. Shop drawings for the installation of a fire suppression system shall be submitted and approved by the Code Authority Having Jurisdiction before any fire suppression system is installed, enlarged, or extended. Under NO circumstances shall any Work be performed prior to receiving shop drawings approved by the Code Authority Having Jurisdiction.

E. Coordinate location of all work with other Contractors and equipment.

F. Work includes, but is not limited to, the following:

1. Wet-pipe sprinkler system.

2. Dry-pipe sprinkler system.

G. Additional Fire Suppression Work Considerations:

1. Job conditions: Contractor shall conduct its own water flow testing.
2. Design complete system and prepare and submit sprinkler layout Drawings and hydraulic calculations for approval. Submit (2) copies of Drawings and calculations for initial review by the Associate and for final approval by the State of Ohio, Department of Commerce, Division of Industrial Compliance, Bureau of Construction Compliance and Division of State Fire Marshal.
3. Submit a final copy of the approved sprinkler layout drawings and calculations to the Owner for record purposes.

1.02 LICENSES

A. Only a Contractor and craftsmen licensed by the State as required shall install this Fire Suppression Work.

1.03 COMPLETION OF FIRE SUPPRESSION SYSTEM

. The fire suppression system shall not be considered complete and acceptable unless, and until, all Code and Governing Agency requirements are satisfied.

END OF SECTION 21 00 00

382

SECTION 21 05 09

GENERAL FIRE SUPPRESSION PIPING REQUIREMENTS

PART 1 GENERAL

1.01 DESCRIPTION

A. The following instructions apply to all piping systems, except where otherwise noted:

1. Piping Drawings are schematic. Carefully coordinate final locations.

2. Provide unions or flanges at each final connection and at each piece of equipment. Arrange piping, and locate unions and flanges, to permit easy removal of parts and equipment for inspection and cleaning. Welded connections are prohibited.

3. Where connection size is smaller than piping, make reduction at final connection only. Do not reduce size of pipe drop. Arrange all piping in accordance with the best standards of the Trade, with vertical lines plumb and horizontal runs parallel or perpendicular to the building walls.

4. Provide valves and specialties as required.

B. If other means of draining are not provided, install drain valves at all low points to permit complete draining of the fire suppression system.

C. Contractor shall provide information on chases, sleeves, and openings required for its Work to other Contractors. Contractor shall assume cost and responsibility for all cutting and patching resulting from improper coordination of its Work.

PART 2 PRODUCTS

2.01 UNIONS

A. In copper pipe: Bronze 150 lb. ground joint, solder end (do not use wrought copper unions).

B. In steel pipe: Black malleable iron, 250 lb. bronze ground ball joint.

C. Dielectric: Material shall be compatible for the type of service.

2.02 DRAIN VALVES

A. Drain Valves: Milwaukee BA 100H or BA150H. 3/4 in. bronze hose-end ball valve, with cap and chain (where concealed).

B. Other Acceptable Manufacturers: Approved equal by Walworth or Nibco.

2.03 JOINTS

A. Flanged: Cast iron or cast bronze, 125 lb. or higher as required.

B. Gaskets: Nonmetallic. 1/8 in. minimum thickness, fibrous type with double coat of graphite, asbestos-free, ASME B16.21, except use Type 304 stainless steel with carbon steel guide on high temperature piping systems. Use dielectric gaskets where joining dissimilar piping material.

C. Bolts and Other Hardware:

1. Bolts for steel, cast iron, brass and bronze, for 250 lb. SWP, and for 450 deg. F. or below: Carbon steel, with American Standard regular, square heads and American Standard heavy-hexagon, semi-finished nuts.

2. Where equipment is installed outside, all hardware and bolts shall be stainless steel.

3. ASME B18.21, Tee head, high tensile steel bolts and nuts may be used in mechanical joint pipelines.

D. Threaded piping: Use NPT tapered threads. (ASME B1.20.1.)

E. Filler materials:

1. Solder: Shall meet ASTM B32. Alloy Sn94 and Sn95 shall be used.

2. Brazing: Shall meet AWS A5.8.

3. Welding: Shall comply with AWS D10.12.

2.04 NIPPLES

A. Same weight and material as pipe with which they are used, except shoulder nipples shall be extra-heavy. Short nipples are not allowed.

END OF SECTION 21 05 09

SECTION 21 05 29

HANGERS AND SUPPORTS FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide hangers, supports, and inserts required for piping and equipment installed under the Fire Suppression Contract.

B. Provide all necessary inserts, expansion shields, beam clamps, pipe floor supports, and auxiliary steel.

C. For Precast Flexicore Concrete: Provide concrete inserts, toggle bolts, etc., as required for Fire Suppression Work.

D. Furnish the correct size and type of concrete inserts, along with information on their correct location, to the General Trades Contractor, so as not to delay construction.

E. Provide any additional supports, auxiliary steel or fasteners required for attaching to structure.

PART 2 PRODUCTS

2.01 HANGERS

A. Un-insulated Piping:

1. Steel, cast iron, or plastic:

a. 1/2 in. to 8 in.: Anvil Fig. 69. Galvanized carbon steel, adjustable swivel ring.

b. 10 in. and larger: Anvil Fig. 260. Adjustable clevis, carbon steel yoke, U strap, rod, and hex nuts.

2. Copper, 1/2 in. to 4 in.: Anvil Fig. CT 99. Copper-plated hangers, adjustable tubing ring, carbon steel ring, and malleable iron adjusting nut.

B. Vertical Piping: Anvil Fig. 261. Friction riser clamp with 2 point bearing. Use Anvil Fig. CT 121 copper-plated riser clamp for copper pipe. Shorten legs as required to conceal riser clamp within pipe chase and still provide adequate support.

2.02 TRAPEZE HANGERS

A. Unistrut P1000 or Superstrut A1200. Angle iron, or channel of sufficient length to support pipes and insulation on individual hangers, roller supports or saddles with insulation protectors, support capacity, support spacing, trapeze hanger rod diameter, and quantity as required to support total piping load.

B. Provide individual piping attachment to each Unistrut hanger, angle, or channel.

C. Design support system and obtain approval of a Structural Engineer licensed in Ohio. Submit details to the Associate Architect for approval.

2.03 SUPPORTS

A. All fire-suppression piping supports shall comply with the requirements of NFPA 13.

with double nut attachment to the hanger and at the hanger attachment. Sizes are as follows:

PIPE SIZES	ROD DIAMETER
Up to 2 in.	3/8 in.
2 1/2 in. and 3 in.	1/2 in.
4 in. and 5 in.	5/8 in.
6 in.	3/4 in.

C. Beam Clamps (up to 8 in. diameter pipe):

1. Anvil Fig. 227. Top beam clamp, steel jaw, hook rod with nut, and spring washer steel eye-bolt, with Anvil Fig. 157 for appropriate rod diameter.

2. Option: Anvil Fig. 86. Malleable iron clamp, hardened steel cup point set screw with Fig. 89 steel retaining clip. C CLAMPS WITHOUT RETAINING CLIPS ARE EXPRESSLY PROHIBITED.

D. Purlin Clamps: PHD Fig. 290 Purlin Clamp. Malleable iron with jam nut, and pointed steel set screw. Confirm the type to be used with Metal Building Manufacturer, through the General Trades Contractor.

E. Wall Brackets: Carbon steel, back plates, and bolts.

1. Anvil Fig. 194. Lightweight 750 lb. load.

2. Anvil Fig. 195. Medium-weight 1,500 lb. load.

3. Option: Unistrut Superstrut A1200.

2.04 CONCRETE INSERTS

A. Refer to Manufacturer's recommendations for correct selection as to pipe size and loading. Confirm with the General Trades Contractor that the concrete used is of a sufficient strength to hold the insert. Use inserts.

2.05 FINISH

A. Unless otherwise noted, all steel hangers and supports shall be standard black.

2.06 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A36 / ASTM A36M, steel plates, shapes, and bars, black and galvanized.

END OF SECTION 21 05 29

SECTION 21 05 53.02

IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. Identify by labels and tags the following items:

1. Equipment, control cabinets and similar items.

2. Exposed piping.

3. Piping running above accessible ceiling construction.

B. Install aluminum nameplates for equipment, and stencils for piping.

C. Install piping identification at MAXIMUM 25 FT. intervals.

1.02 ACCEPTABLE MANUFACTURERS

A. Seton “Setmark” or approved equal by Brady, MSI, or Calpico.

PART 2 PRODUCTS

2.01 EQUIPMENT IDENTIFICATION

A. Engraved aluminum nameplates, sized for 3/4 in. high letters or numbers, Gothic style.

2.02 PIPING IDENTIFICATION

A. Stencils. Letter size shall be as follows:

OVERALL PIPE SIZE	MINIMUM LETTER HEIGHT
Up to 1-1/4 in. diameter	1/2 in. high
1-1/2 in. to 2 in. diameter	3/4 in. high
2-1/2 in. to 6 in. diameter	1-1/4 in. high

2.03 IDENTIFICATION SCHEDULE

A. Identify as follows:

TYPE OF SERVICE	BACKGROUND COLOR	TEXT COLOR	DESIGNATION
Wet Sprinkler	Red	White	FIRE-WET
Drain	Green	White	D

END OF SECTION 21 05 53.02

SECTION 21 13 00.01

FIRE SUPPRESSION SPRINKLER SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide fire suppression specialties or accessories as required by either the Equipment Manufacturer or the Local Code Authority.

1.02 ACTION SUBMITTALS

A. Product data.
B. Shop Drawings:

- Prepare in accordance with NFPA 13 section "Working Plans."
    - Plans, elevations, and sections of the system piping and details.
    - Detailed riser diagram and schematic diagram showing system supply, supply connection, devices, valves, pipe and fittings, as well as the delineation of the standard-pressure portions of the fire-suppression system.
    - Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- Prepare computer-generated hydraulic calculations in accordance with the following:
    - Name of hydraulic program used.
    - Water supply information, including fire hydrant flow test data report.
- Submit documents and calculations prepared by NICET Level III-certified technician, "Water-Based Systems Layout."
- Include diagrams for power, signal, and control wiring.

C. Delegated Design Submittals: For fire-suppression systems indicated to comply with performance requirements and design criteria, including analysis data, prepared by NICET Level III-certified technician, "Water-Based Systems Layout." NICET certified-technician submittals are to include the following information on each drawing title block: technician's name, NICET certification number, and NICET certification specialty area and level.

1.03 QUALITY ASSURANCE

A. Installer Qualifications:

- Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
    - Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a NICET Level III-certified technician, "Water-Based Systems Layout."

PART 2 PRODUCTS

2.01 WATERFLOW SWITCHES

A. Potter Electric Signal Model VSR F. Vane-type sectional, with (2) SPDT snap action switches, 40 deg. F. to 120 deg. F. operating temperature range, 250 PSI service pressure, 8 GPM to 10 GPM minimum flow activation for alarm activation, and die-cast aluminum enclosure.

2.02 VALVE SUPERVISORY SWITCHES

A. OS&Y Valves: Potter Electric Signal Model OSYSU 1. NEMA 4 and 6P, weather-resistant and submersible tamperproof switch on cover, single-pole double-throw switch, roller-type switch actuator, and spring-loaded plunger. Double-pole switches shall not be acceptable.

B. Post Indicator or Butterfly Valves: Potter Electric Signal Model PCVS 1. Weatherproof, tamper-resistant, (1) or (2) single-pole double-throw switches, constructed of die-cast aluminum, tamper switch cover, with 1/2 in. male fitting for attachment to post indicator or butterfly valve.

2.03 PRESSURE GAUGES

A. Winters Thermogauges, Inc., Product Code Q1721. Aluminum dial, steel case, brass socket, 4 in. diameter, 1/4 in. NPT male connection, with range of 0 PSIG to 250 PSIG.

B. Provide spare gauge.

C. Other Acceptable Manufacturers: Approved equal by Ashcroft, Marsh, Marshalltown, Trerice, Weksler, or Weiss.

2.04 INSPECTOR'S TEST AND DRAIN ASSEMBLY

A. AGF Manufacturing Co. Model 1011T. 1 in. test and drain ball valve, with locking kit and lock with (2) keys, pressure-relief valve, pressure gauge, and 1/4 in. 3 way globe valve, with flow equivalent to (1) sprinkler.

B. Other Acceptable Manufacturers: Approved equal by Reliable Automatic Sprinkler Co. or Tyco Fire Products.

2.05 IDENTIFICATION SIGNS

A. Reliable Automatic Sprinkler Co. Model A:

a. Valve control: Style A.

b. Specific identification: Style B.

c. Fire alarm: Style D.

d. Hydraulic calculated system: Style E.

2. 20 ga. steel, porcelain-enameled, white lettering on red background. Cold weather: Style C.

B. Other Acceptable Manufacturers: Approved equal by Globe Fire Sprinkler Corp. or Tyco Fire Products.

2.06 DRAINS

A. Furnish drains using Schedule 80 black steel pipe (ASTM A53). Exception: Through exterior walls, the piping shall be galvanized or non-ferrous.

2.07 HANGERS

A. All hangers shall support (5) times the total load of the water-filled pipe in addition to a minimum of 250 lb. load applied at the hanger per NFPA 13.

B. Comply with requirements of Section 21 05 29.

C. All hangers installed shall be appropriate for type of building structure indicated. USE OF “C” CLAMPS WITHOUT RETAINING STRAPS IS PROHIBITED.

2.08 FIRE DEPARTMENT (SIAMESE) CONNECTION

A. Potter Roemer Model 5021 D: flush-mounted, back outlet, polished chrome-plated finish, 2 way connection, 2 1/2 in. x 2 1/2 in. inlets, complete with (2) clapper valves, 2 1/2 in. nipples, snoots, swivels, plugs, chains, and escutcheon plate. Type of threads and exact location of the connection shall comply with the requirements of the Local Fire Department. Verify before ordering. Metal escutcheon plate lettered “AUTO SPKR,” with raised letters at least 1 in. in height, shall match pump test connection escutcheon plate. Torque caps shall prevent removal without tools.

B. Other Acceptable Manufacturers: Approved equal by Elkhart Brass, Guardian, Firematic, or Croker.

C. Install the automatic drain device inline to drain low point of the system between the Fire Department connection and the swing check valve.

2.09 AUTOMATIC DRAIN DEVICE

A. Potter-Roemer Model 5982 or 5984. Cast brass, 3/4 in. size, and threaded inlet and outlet.

B. Install in a horizontal position where indicated on the Drawing.

PART 3 – EXECUTION

3.01 PREPARATION

A. Perform fire-hydrant flow test. Use results for system design calculations required in "Quality Assurance" Article.

2. Flow test is to be conducted in accordance with NFPA 291.
3. Test is to be performed during a period of ordinary demand for the water system.

    a. To obtain satisfactory test results of expected flow or rated capacities, sufficient discharge should be achieved to cause drop of at least 10 percent.

4. Pitot readings are to be taken at the 2-1/2-inch (65-mm) orifice connection.
5. The pitot reading is to range from 10 to 35 psig (68.9 kPa to 241.3 kPa).
6. Open additional hydrant outlets as needed to control pitot readings.
7. The pitot pressure and corresponding residual pressure readings are to be taken consecutively as pressure fluctuates between a high number and low number.

B. F ow Test Data Written Report:

1. Flow data report is to be written in accordance with NFPA 291.
2. Flow data report is to include a copy of all flow data recorded during the test, including a site plan showing the tested fire hydrants with respect to the fire water service to the building. Site plan is to indicate which hydrant was flowed and which hydrant was used for pressure reading. Provide date of test, name of testing agency, and name of individual performing test.

C. Water Supply Curve: Provide water supply curve based on the lowest supply for a given set of test data. For a given residual pressure reading, the supply is to be graphed utilizing the corresponding pitot pressure/flow reading and static pressure reading.

D. Documentation is to include calibration certifications for gauges used in the flow tests. The certifications are to be from within the previous six (6) months from a reputable agency recognized for certifying pressure gauges.

E. Report flow test results promptly and in writing. A copy of the flow test data report is to be submitted with the hydraulic calculations.

3.02 INSTALLATION OF FIRE-SUPPRESSION PIPING

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

1. Deviations from approved working plans for piping require written approval from AHJs. File written approval with Architect before deviating from approved working plans.
2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with NFPA 13 requirements for installation of fire-suppression piping.

C. I nstall seismic restraints on piping. Comply with NFPA standards requirements for seismic-restraint device materials and installation.

D. Install listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

located in accordance with NFPA 13.

H. Install fire-suppression system piping with drains for complete system drainage. Extend drain piping to exterior of building where possible.

I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

J. Install automatic (ball drip) drain valve at each check valve for fire department connection, to drain piping between fire department connection and check valve. Install drain piping to and spill over floor drain or to exterior of building.

K. Install alarm devices in piping systems.

L. Install hangers and supports for fire-suppression piping in accordance with NFPA standards. Comply with requirements for hanger materials in NFPA standards. In seismic-rated areas, refer to Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

M. Install pressure gauges on riser or feed main, at each sprinkler test connection, and at top of each standpipe/sprinkler supply. Include pressure gauges with connection not less than NPS 1/4 (DN 8) and with soft-metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they are not subject to freezing.

N. Pressurize and check dry-pipe standpipe or sprinkler system piping and air-pressure maintenance devices.

O. Fill wet-type fire-suppression system piping with water.

P. Drain dry-type fire-suppression system piping.

Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210500 "Common Work Results for Fire-Suppression Piping."

3.03 INSTALLATION OF PIPING JOINTS

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

D. Ream ends of pipes and tubes and remove burrs.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts in accordance with ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.

H. Steel-Piping, Pressure-Sealed Joints: Join steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe joints.

J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe grooved joints.

K. Extruded-Tee Connections: Form tee in copper tube in accordance with ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

L. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.04 INSTALLATION OF FIRE DEPARTMENT CONNECTIONS

A. IInstall wall-type fire department connections.

B. Install yard-type fire department connections in concrete slab support. Comply with requirements for concrete in Section 033000 "Cast-in-Place Concrete."

C. Install protective pipe bollards around each fire department connection as shown on structural and civil drawings.

D. Install automatic (ball-drip) drain valve at each check valve for fire department connection.

3.05 INSTALLATION OF HOSE CONNECTIONS

A. Examine roughing-in for hose connections to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thickness, fire- and smoke-rated construction, and other conditions where hose connections are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. I nstall hose connections adjacent to standpipes.

E. Install freestanding hose connections and hose stations for access and minimum passage restriction.

F. Install NPS 1-1/2 (DN 40) hose-connection and hose-station valves with flow-restricting device unless otherwise indicated.

G. Install NPS 2-1/2 (DN 65) hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40) reducer adapter and flow-restricting device unless otherwise indicated.

H. Install wall-mounted-type hose connections and wall-mounted, rack hose stations in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates

in Section 104413 "Fire Protection Cabinets."

I. Install freestanding hose stations with support or bracket attached to standpipe.

J. Install hose-reel hose stations on wall with bracket.

3.06 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

A. Install cover system, brackets, and cover components for sprinkler piping in accordance with manufacturer's installation manual and in accordance with NFPA 13 or NFPA 13R for supports.

3.07 INSTALLATION OF VALVES AND SPECIALTIES

A. Install listed fire-suppression system control valves, trim and drain valves, specialty valves and trim, controls, and specialties in accordance with manufacturer's installation instructions, NFPA standards, and AHJ.

B. Install listed fire-suppression system shutoff valves in supervised open position, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. System Control Valves:

1. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
2. Install dry-pipe valves with trim sets for air supply, drain, priming level, alarm connections, ball-drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.

a. Install air-pressure maintenance device with shutoff valves to permit servicing without shutting down system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14 to 60 psig (95 to 410 kPa) > adjustable range; and 175 psig (1200 kPa) maximum inlet pressure.
b. Install compressed-air-supply piping from building's compressed-air piping system.

D. Air Vent:

1. Provide at least one air vent at high point in each wet-pipe fire-suppression system in accordance with NFPA standards. Connect vent into top of fire-suppression piping.
2. Provide dielectric union for dissimilar metals, ball valve, and strainer upstream of automatic air vent.

3.08 INSTALLATION OF SPRINKLERS

A. Install sprinklers in suspended ceilings symmetrically in center of acoustical ceiling panels within tolerance of 1/2 inch (12.7 mm). Coordinate entire pattern of sprinkler locations with approved reflected ceiling plan.

B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

A. Install labeling and pipe markers on equipment and piping in accordance with requirements for identification specified in Section 210553 "Identification for Fire-Suppression Piping and Equipment."

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Perform the following tests and inspections

i. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
ii. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
iii. Flush, test, and inspect fire-suppression systems in accordance with NFPA standards.
iv. Energize circuits to electrical equipment and devices.
v. Start and run air compressors.
vi. Coordinate with fire-alarm tests. Operate as required.
vii. Coordinate with fire-pump tests. Operate as required.
viii. Verify that equipment hose threads are same as local fire department equipment.
ix. Verify that sprinklers original factory finish has not been contaminated with dirt, debris, or paint. Sprinklers containing other-than-original factory finish are to be considered defective and replaced with new products. Repair and/or cleaning is not acceptable.

C. Fire-suppression piping system will be considered defective if it does not pass tests and inspections.

D. Fire-suppression piping system components considered defective during testing will be replaced with new components. Repair of defective components is not acceptable.

E. Prepare test and inspection reports.

3.11 CLEANING

A. Clean dirt and debris from fire-suppression system piping, system control valves, sprinklers, and associated components.

b. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.12 DEMONSTRATION

A. Train Owner’s maintenance personnel to adjust, operate, and maintain system.

END OF SECTION 21 13 00.01

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.01 GUARANTEE

A. Contractor shall guarantee its equipment, workmanship, and materials for a period of (1) year from the date of Contract Completion. Should defects develop within this period, the Contractor shall, at no cost to the Owner, remedy the defects and reimburse the Owner for all damage to other Work caused either by the defects or as a result of the work of correcting the same.

B. Refer also to Division 01 and other Specification Sections that define the starting date of the guarantee period, or that discuss either additional warranty requirements, or extended equipment warranties beyond the standard period.

C. In Drywall, Masonry, or Concrete Wall Construction:

1. Option for above ceiling only: omit block(s) where required for penetrations, and shall provide square finished opening. Do not omit blocks under bearing points or in fire rated or smoke rated walls. Do not omit blocks in walls which serve as sound barriers.

2. Provide openings through metal building walls and roofs, and seal watertight.

D. In precast concrete work, in lieu of sleeves, cut holes after erection of concrete.

E. Sleeve where pipes pass exposed through walls, and where any piping passes through smoke-rated or fire-rated separations, equipment room walls, or above-grade floors.

F. If sleeves are not installed in construction, due to fault of the Contractor, holes through masonry or concrete construction shall be core drilled at the expense of the Contractor.

G. Sleeves are not required in floor slabs on grade or in core-drilled openings not requiring water-proofing or firestopping. EXCEPTION: Sleeves are required at core drilling through hollow core pre-cast slabs and through concrete block walls, to facilitate containment of required firestopping material.

H. Sleeving with absolutely watertight seal is required for piping passing through exterior walls above grade, and underground foundation walls and other below-grade penetrations into building.

PART 2 PRODUCTS

2.01 DESIGN BASE MANUFACTURER STANDARD

A. The Drawings and Specifications are based on the specific equipment requirements and configuration for a Design Base Manufacturer. Design coordination of equipment with the building and with other Trades has been made for this specific Model and Manufacturer of equipment. Where several Manufacturers are listed for an item of equipment or material, the first-named shall be considered the Design Base Manufacturer Standard.

unless the Manufacturer has been approved by the A/E and specifically named in the Contract Documents or Addenda thereto.

2.02 OTHER MANUFACTURERS

A. No consideration will be given to any Manufacturer which the Contractor proposes as an "Approved Equal," unless the Manufacturer has been approved by the A/E during the bid period and specifically named in the Contract Documents or Addenda thereto.

B. Recognizing that since no two Manufacturers are "identical," whenever the Contractor elects to furnish specified equipment or material manufactured by other than the Design Base Manufacturer, the Contractor shall be responsible for the cost and coordination of all modifications required to accommodate the elected equipment or material.

C. Where deemed necessary by the A/E, the Contractor shall, at no additional cost to the Owner, prepare new layouts for these other brands of equipment which may have different dimensional or service requirements from the Design Base Manufacturer Standard. Submit these layouts to the A/E for review.

D. Reimburse the A/E for the cost of any design changes incurred by the A/E in the preparation of revised Drawings or Specifications to accommodate the use of any Manufacturer other than the Design Base Manufacturer.

2.03 ALTERNATIVE MANUFACTURERS

A. Contractor shall submit information on any proposed equipment or material that it desires to use as an Approved Equal.

B. If the A/E determines an alternative Manufacturer to be acceptable, it will issue an Addendum adding that Manufacturer to the Specification.

2.04 EQUIPMENT SUITABILITY

A. All equipment provided shall perform as intended. All items listed shall function properly, and as the Manufacturer intended. Install equipment according to the Manufacturer's recommendations. Properly attach equipment to the floor, wall, or structure. Each item of equipment shall be compatible with all other accessories or hook-ups, including piping, controls, wiring, and other equipment that are not furnished by the equipment Manufacturer, but that are required as an accessory or modification, as necessary to achieve its intended function.

2.05 MISCELLANEOUS ACCESSORIES

A. Provide any additional adapters, fittings, trim, structural steel angles, channels, Unistrut, brackets, etc., as necessary to securely mount and install all items of equipment specified or shown on the Drawings. All steel installed outside or exposed to moisture shall be hot-dipped galvanized.

B. These accessories are required even though they may not be shown or detailed on the Drawings.

C. Installation shall be compatible with the building construction on which the item is to be located.

accessories are included.

2.06 QUANTITIES

A. Equipment may be referred to in these Specifications, or on the Drawings, as either singular or plural; the Contractor shall verify the exact number of items required to complete its Work.

2.07 STANDARD SLEEVES

A. Pipe sleeve material:

1. Up to 8 in. diameter: Machine-cut Schedule 40 black steel pipe.

2. Bare copper piping: Copper sleeves.

3. OPTION: In walls: Schedule 40 plastic pipe may be used for pipe sleeves, except where adjacent ceiling space is used for return air plenum.

B. Sizing: Sleeves shall be large enough for insulation to be continuous, or for watertight or fire-rated sleeve seals to be installed. Size to allow 1/2 in. minimum clearance all around pipe or pipe insulation.

2.08 WATERTIGHT SLEEVE SEALS

A. Oakum Caulking: With lead-pour or elastomeric sealant. Elastomeric sealant shall be 2 component, polysulfide or polyurethane.

B. OPTION: Compression Seals: Stainless steel bolts and nuts. Provide correct size seal, and coordinate with sleeve size.

C. Provide sleeves with waterstop anchor flange at midpoint where penetrating structure at or below grade.

2.09 FIRE-RATED SLEEVE SEALS

A. ASTM E119 and E814 Silicone RTV foam, UL-approved.

B. Plastic drain, waste, and vent stacks, and lines penetrating fire-rated floors, ceilings, and walls shall be fire-blocked and waterproofed using ProSet Systems, Inc., Series 45 or 55 couplings and Series 90 Code Red Firestop devices. All other plastic drain openings, such as closet stubs, and floor drains, shall be fire-blocked and waterproofed using ProSet Systems C, and E Z Flex flexible couplings.

2.10 PAINTING OF ELECTRICAL SYSTEMS

A. Refer to Division 9 for painting specifics.

B. Plumbing systems shall be painted to match adjacent finishes.

END OF SECTION 22 05 00

SECTION 22 05 05

PLUMBING EXCAVATION AND BACKFILL

PART 1 GENERAL

1.01 DESCRIPTION

A. The bedding and backfill requirements listed in this Section represent a minimum requirement. If Local or State requirements are in excess of listed requirements, such requirements shall supersede.

B. ALL EXCAVATION AND BACKFILL WORK SHALL COMPLY WITH REQUIREMENTS OF THE LATEST STANDARDS OF THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA).

C. Provide excavation and backfilling for Plumbing Work. Backfill to finish grade or to levels suitable for finish grading.

D. Refer to Section 22 05 00 for cutting and patching responsibilities.

E. Coordinate routing of underground lines with the A/E to minimize disruption and damage to trees, shrubs, walks, drives, and other landscape features.

F. Excavation, backfill, surface repair and traffic control within the public right-of-way shall be in accordance with governing agency rules and regulations. Pay any fee associated with alteration of the roadway.

G. Remove unusable or surplus excavated material from the site. Deposit any usable excavated material where directed by the A/E.

H. Locate and touch existing underground utilities, if any, in the areas of Work. If utilities are to remain in place, provide adequate means of protection during earthwork operations. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, notify the A/E immediately for instructions before proceeding. Cooperate with all trades, Utility Companies and the Owner in keeping services and the facilities in operation.

I. Excavation damage to, or interruption of service of, any underground utility shall be a liability of the Contractor, whether or not plotted on the Drawings. Promptly repair or replace all damage to any existing utility to the full satisfaction of the Utility Company, the Utility Owner and the A/E.

J. All existing utility service piping, conduits, wiring, etc., which are uncovered, whether within or beyond the property lines, shall be suitably supported, protected and maintained in operation, and shall be protected against settlement when excavations are refilled.

K. Coordinate timing of excavations where required by the Authority Having Jurisdiction or where otherwise specified herein.

L. Provide pipe bedding for all sanitary sewer lines located outside of building.

M. Provide pipe bedding for all sanitary sewer lines located below the floor slab.

N. Obtain approval from the A/E for bearing conditions.

proper foundations will be made and the Contract price will be adjusted accordingly.

P. Contact the A/E to obtain copies of Soils reports, if available. Bidders are strongly urged to visit the site and investigate existing soil conditions themselves.

Q. 11 months after Contract Completion, review the excavated areas and add any backfill as required due to settling, etc. Re-seed or re-sod as required.

R. Contractor shall provide seed grass cover to reestablish landscape to existing conditions where disturbed by its Work. This includes replacement of existing plants, shrubs, and related items.

S. Repair and restore plants, shrubs, trees, sodden areas, paving, streets, curbs, and walks to match existing in the area where excavations are made.

T. Maintain seeded lawns not less than 11 months after Contract Completion and add any backfill as required due to settling, etc. If seeded in non-growing season and not given full 11 months of maintenance, or if not considered acceptable at that time, continue the following growing season until an acceptable lawn is established, as determined by the A/E.

U. Rock excavation is not anticipated. Contractor will be entitled to additional compensation for excavating any rock that is not indicated on the Contract Drawings or in available Soils Reports. Refer to available soil boring data.

1. If rock or boulders are encountered, immediately stop all excavation. Notify the A/E, and submit a cost per cubic yard, over and above Base Bid, for excavation and backfill of rock areas. Rock excavation is defined as the excavation of any buried boulders and rock, in excess of 1/2 cu. yd. in volume, which requires the systematic drilling with jackhammer or use of other special equipment.

2. All other excavation, including soft shale and similar sedimentary soil formations, shall be regarded as “earth” excavation, and shall be included in the Contractor’s Bid.

3. Do not proceed with rock excavation without prior written authorization of the A/E.

4. The use of explosives is expressly prohibited.

V. Provide concrete encasement required for underground piping. Where required, concrete encasement shall extend 6 in. around piping or sleeve, for 1 ft. each side of footings or foundations, and up to footing bearing elevation. Backfill around piping encasement after concrete has properly hardened.

1. All concrete shall be 3,000 PSI minimum and placed in accordance with applicable ACI Standards. Refer to Section 03 30 00.

PART 2 PRODUCTS

2.01 BACKFILL

A. Typical backfill conditions:

1. Piping where bedding is not specified or required by Code: Previously excavated material.

pea gravel, or coarse sand from 4 in. below piping to slab.

3. Other piping outside building: Pea gravel from 4 in. below piping to 12 in. minimum above pipe, then previously excavated material.

4. Piping under drives and parking lots: Pea gravel from 4 in. below piping to 12 in. minimum above pipe, then previously excavated material. If pipe is less than 2 ft. below grade to top of pipe, provide 6 in. concrete encasement.

5. Concrete pads and bases: Granular material conforming to Division 02 requirements.

6. Piping under footings and foundations: Provide concrete encasement.

7. Underground oil interceptor: Pea gravel.

B. Materials:

1. Crushed stone: (ODOT Item 304).

2. Pea gravel: 1/8 in. minimum to 3/4 in. maximum diameter.

3. Sand: Clean, dry, coarse or medium.

4. Washed gravel: 3/4 in. size.

5. Concrete encasement: Material conforming to Division 03 requirements.

C. Materials Prohibited from Being Used for Backfill:

1. Material containing large rocks (over 2 in.), building materials, masonry debris, cinders, rubbish, wood, or other material subject to decay.

2. Any material which may cause damage to piping.

3. Frozen earth.

2.02 PAVING

A. Asphalt Paving:

1. Aggregate base: ODOT Item 304, 8 in. total, compacted in (2) 4 in. layers.

2. Base course: ODOT Item 402, 1 3/4 in. thickness.

3. Surface course: ODOT Item 404, 1 1/4 in. thickness.

4. Tack coat: ODOT Item 407.

5. Prime coat: ODOT Item 408.

B. Sealer: ODOT Item 409.

END OF SECTION 22 05 05

SECTION 22 05 08

PLUMBING ELECTRICAL COORDINATION

PART 1 GENERAL

1.01 DESCRIPTION

A. This contract is single prime therefore all coordination between trades is done by the prime contractor. This specification may be used as a guide for the single prime contractor.

1.02 COORDINATION

A. Plumbing Contractor shall coordinate its Work as follows:

1. PLUMBING ITEMS:

a. Electric Water Coolers: Plumbing Contractor shall coordinate location and electrical requirements with the Electrical Contractor. Electrical Contractor shall provide receptacle and wiring. Plumbing Contractor shall provide electric water cooler with cord and plug, and shall plug in.

b. Domestic Water Heaters: Plumbing Contractor shall coordinate location and electrical requirements with the Electrical Contractor. Electrical Contractor shall provide disconnect switches/or plug and wiring.

c. Food Waste Grinder: Electrical Contractor shall provide wall switch and wiring.

d. Air Compressor: Shall include a motor starter. Electrical Contractor shall provide disconnect switch and wiring, and wall mounted pilot light switch.

e. Refrigerated Air Dryer: Plumbing Contractor shall provide refrigerated air dryer with cord and plug, and shall plug in. Electrical Contractor shall provide receptacle and wiring.

2. ELECTRICAL ITEMS:

a. Generator: Plumbing Contractor shall provide natural gas piping to back-up generator.

PART 2 PRODUCTS

2.01 CONTROL WIRING

A. Electrical Contractor shall provide all control wiring.

END OF SECTION 22 05 08

417

SECTION 22 05 09

GENERAL PLUMBING PIPING REQUIREMENTS

PART 1 GENERAL

1.01 DESCRIPTION

A. The following instructions apply to all piping systems, except where otherwise noted:

1. Piping Drawings are schematic. Carefully coordinate final locations.

2. Provide unions or flanges at each final connection and at each piece of equipment. Arrange piping, and locate unions and flanges, to permit easy removal of parts and equipment for inspection and cleaning. Welded connections to equipment are prohibited.

3. Where connection size is smaller than piping, make reduction at final connection only. Do not reduce size of pipe drop. Arrange all piping in accordance with the best standards of the Trade, with vertical lines plumb, and horizontal runs parallel or perpendicular to the building walls.

4. Provide valves and specialties as required. Install valves on each piece of equipment.

B. If other means of draining are not provided, install drain valves at all low points to permit complete draining of each of the following systems:

1. Domestic water system.

2. Compressed air system.

C. Contractor shall provide information on chases, sleeves, and openings required for its Work to other trades. Contractor shall assume cost and responsibility for all cutting and patching resulting from improper coordination of its Work.

PART 2 PRODUCTS

2.01 UNIONS

A. In copper pipe: Bronze 150 lb. ground joint, solder end (do not use wrought copper unions).

B. In steel pipe: Black malleable iron, 250 lb. bronze ground ball joint.

C. Dielectric: Material shall be compatible for the type of service.

2.02 DRAIN VALVES

A. Drain Valves: Milwaukee BA 100H or BA150H. 3/4 in. bronze hose-end ball valve, with cap and chain (where concealed).

B. Other Acceptable Manufacturers: Approved equal by Walworth or Nibco.

2.03 JOINTS

A. Flanged: Cast iron or cast bronze, 125 lb. or higher as required

asbestos-free, ASME B16.21, except use Type 304 stainless steel with carbon steel guide on high temperature piping systems. Use dielectric gaskets where joining dissimilar piping material.

C. Bolts and Other Hardware:

1. Bolts for steel, cast iron, brass, and bronze, for 250 lb. SWP, and for 450 deg. F. or below: Carbon steel, with American Standard regular, square heads and American Standard heavy-hexagon, semi-finished nuts.

2. Where equipment is installed outside, all hardware and bolts shall be stainless steel.

3. ASME B18.21, Tee head, high tensile steel bolts and nuts may be used in mechanical joint pipelines.

D. Threaded piping: Use NPT tapered threads. (ASME B1.20.1.)

E. Filler materials:

1. Solder: Shall meet ASTM B32. Alloy Sn94 and Sn95 shall be used.

2. Brazing: Shall meet AWS A5.8.

3. Welding: Shall comply with AWS D10.12.

2.04 NIPPLES

A. Same weight and material as pipe with which they are used, except shoulder nipples shall be extra-heavy. Short nipples are not allowed.

END OF SECTION 22 05 09

SECTION 22 05 10

PLUMBING PIPING EXPANSION, NOISE, AND VIBRATION ISOLATION

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide thermal expansion control for all piping.

B. Isolate all piping for both noise and vibration transmission.

C. To prevent damage to building, equipment, joists, hangers and piping, provide expansion loops, guides, anchors and offsets in piping systems as necessary to accurately control pipe movement due to equipment operation or thermal gradients.

D. Provide flexible connectors on all piping to equipment 5 HP and larger, and where shown for equipment of lower horsepower.

E. Provide expansion joints and accompanying anchors and guides where expansion cannot be provided for with loops and offsets (not shown).

F. Anchor points are not indicated on Drawings. Install anchor points as needed to properly control piping movement. Typically piping shall be anchored at tees, elbows and bends. Piping shall also be anchored in each direction.

1.02 ACCEPTABLE MANUFACTURERS

A. Metraflex Company or approved equal by Hyspan Precision Products, Inc., Flexicraft, Flexonics Products, Minnesota Flexible Corp., Uniroyal General Rubber, or Twin City Hose, Inc.

B. Manufacturer and Model Number listed under Part 2 shall be considered to be the Design Base Manufacturer and Model Number. Other Acceptable Manufacturers will be permitted, unless specifically excluded.

PART 2 PRODUCTS

2.01 EXPANSION JOINTS

A. Stainless steel bellows and elements; cast iron equalizing rings, tie-rods, and pipe connections as required; 250 PSIG working pressure. Use packless, internally guided type for lines 2 in. and smaller.

B. 2 in. and Smaller Lines: Metraflex HPMF. Stainless steel with copper sweat ends, packless, internally guided expansion compensator type.

2.02 PIPE ALIGNMENT GUIDES

A. Painted steel cylinder guide assembly with welded mounting brackets, 2 piece pipe clamp “Spider” assembly.

END OF SECTION 22 05 10

420

SECTION 22 05 23

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide valves to facilitate maintenance and isolation of piping systems.

1.02 ACTION SUBMITTALS

A. Product data.

PART 2 PRODUCTS

2.01 BALANCING VALVES (2 IN. AND SMALLER)

A. 200 PSIG, ASTM B 62 bronze body/brass ball, threaded or solder joint ends, differential pressure read-out ports, 1/4 in. drain port, memory stop feature to allow valve to be closed for service and reopened to setpoint without disturbing balance position, and calibrated nameplates to ensure specific valve settings.

B. Acceptable Manufacturers: ITT Bell & Gossett CB Series, Nibco Fig. 1710, or Taco ACUF Series.

2.02 BALL VALVES (3 IN. AND SMALLER)

A. 150 lb. SWP, bronze body, threaded or solder joint ends, TFE seat and seals, stainless steel ball, blow-out-proof stem, extended handle with vapor seal, adjustable memory stop, and protective sleeve.

1. ONLY Acceptable Ball Valve Manufacturers: Milwaukee Model BA 100 or BA 150 or approved equal by Watts No. B 6000 or B 6001, Apollo 70 100 or 70 200, Hammond 8501 or 8511, Nibco 580-70 or 585-70, or Kitz 68 or 69.

B. With Lockable Handles: 150 lb. SWP, bronze body, threaded ends, TFE seat and seals, stainless steel ball, extended handle with vapor seal, adjustable memory stop, and protective sleeve.

1. Acceptable Manufacturers of ball valves with lockable handles: Milwaukee Model BA 100 LD, Apollo No. 70 100 27, or Nibco 580 70 LH.

2.03 CHECK VALVES

A. 2 in. and Smaller: Milwaukee Fig. 509 or 1509. 125 lb. SWP, ASTM B 62 bronze body, swing check, threaded or solder joint tubing ends, with renewable bronze disc and integral seat.

B. 2 1/2 in. and Larger (swing): Milwaukee Fig. F 2974. 125 lb. SWP, iron body, bronze trim, with flanged ends.

2.04 DRAIN VALVES

A. Milwaukee Fig. BA 100H or BA 150H (threaded or soldered ends). 3/4 in. bronze hose-end ball valve, with cap and chain.

PART 3 – EXECUTION

3.01 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.

D. For valves in horizontal piping, install valves with stem at or above center of pipe.

E. Install valves in position that does not project into aisles or block access to other equipment.

F. Install valves in position to allow full stem and actuator or manual operator movement.

G. Verify that joints of each valve have been properly installed and sealed to assure there is no leakage or damage.

H. Chainwheels: Install chainwheels on manual operators for **butterfly and gate** valves **NPS 4 (DN 100)** and larger and more than **96 inches (2400 mm)** above floor. Extend chains to **60 inches (1520 mm)** above finished floor. Confirm chainwheel locations with owner.

I. Install check valves for proper direction of flow and as follows:

1. Check Valves, Swing Type: In horizontal position with hinge pin level.

J. Valve Tags: Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

K. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's written recommended maximum

3.02 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.

6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
7. For Grooved-End Copper Tubing: Valve ends may be grooved.
8. For Grooved-End Steel Piping: Valve ends may be grooved.
9. Wafer-Type Valves: Flanged connections.

END OF SECTION 22 05 23

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal hanger-shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Pipe-positioning systems.
10. Equipment supports.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 ACTION SUBMITTALS

A. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Fiberglass strut systems.
4. Pipe stands.
5. Equipment supports.

B. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Include design calculations for designing trapeze hangers.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to **ASCE/SEI 7.**

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized **carbon steel**.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of **copper-coated steel**.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 FIBERGLASS PIPE HANGERS

A. Clevis-Type, Fiberglass Pipe Hangers:

1. Description: Similar to MSS SP-58, Type 1 steel pipe hanger, except hanger is made of fiberglass or fiberglass-reinforced resin.
2. Hanger Rods: Continuous-thread rod, washer, and nuts made of **fiberglass**
3. Flammability: ASTM D635, ASTM E84, UL 94.

B. Strap-Type, Fiberglass Pipe Hangers:

1. Description: Similar to MSS SP-58, Type 9 or Type 10 steel pipe hanger, except hanger is made of fiberglass-reinforced resin.

   a. Flammability: ASTM D635, ASTM E84, UL 94.

2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of **stainless steel**.

2.5 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ABB (Electrification Products Division).
   b. Atkore International (Unistrut).
   c. Eaton (B-line).
   d. Flex-Strut Inc.
   e. G-Strut.
   f. Haydon Corporation.
   g. Wesanco, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
4. Channels: Continuous slotted galvanized **carbon-steel or stainless-steel, Type 304** channel with inturned lips.
5. Channel Width: Selected for applicable load criteria.
6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized **carbon steel**.
8. Metallic Coating: **Pregalvanized G90**.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Anvil International.
   b. Carpenter & Paterson, Inc.
   c. Empire Industries, Inc.
   d. FNW; Ferguson Enterprises, Inc.
   e. Gripple Inc.
   f. HOLDRITE; Reliance Worldwide Company.
   g. MIRO Industries.
   h. nVent (CADDY).
   i. PHD Manufacturing, Inc.
   j. Rooftop Support Systems, a division of Eberl Iron Works, Inc.
   k. Sioux Chief Manufacturing Company, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
4. Channels: Continuous slotted galvanized **carbon-steel** channel with inturned lips.
5. Channel Width: Select for applicable load criteria.
6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized **carbon steel**.
8. Metallic Coating: **Pregalvanized G90**

2.6 FIBERGLASS STRUT SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Atkore International (Unistrut).
2. Champion Fiberglass, Inc.
3. Fabco Plastics Wholesale Limited.
4. G-Strut.
5. Seasafe, Inc.; AMICO, a Gibraltar Industries Company.

B. Description: Structural-grade, factory-formed, glass-fiber-resin channels and angles for supporting multiple parallel pipes.

1. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
2. Channels: Continuous slotted fiberglass-reinforced plastic channel with inturned lips.
3. Channel Width: Selected for applicable load criteria.
4. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
5. Fitting and Accessory Materials: Same as those for channels and angles**, except metal items may be stainless steel**.
6. Rated Strength: Selected to suit applicable load criteria.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.7 THERMAL HANGER-SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Buckaroos, Inc.
2. Carpenter & Paterson, Inc.
3. National Pipe Hanger Corporation.
4. nVent (CADDY).
5. Pipe Shields Inc.
6. Piping Technology & Products, Inc.
7. Rilco Manufacturing Co., Inc.
8. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: **ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig** minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: **ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig** minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.8 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Hilti, Inc.
    b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
    c. MKT Fastening, LLC.
    d. Simpson Strong-Tie Co., Inc.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Eaton (B-line).
    b. Empire Tool and Manufacturing Co., Inc.
    c. Hilti, Inc.
    d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
    e. MKT Fastening, LLC.

2. Indoor Applications: **Zinc-coated** steel.
3. Outdoor Applications: Stainless steel.

2.9 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand:

1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.

3. Hardware: Galvanized steel or polycarbonate.
4. Accessories: Protection pads.

C. Low-Profile, Single-Base, Single-Pipe Stand:

1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.

3. Vertical Members: Two **galvanized**-steel, continuous-thread, 1/2-inch rods.
4. Horizontal Member: Adjustable horizontal, **galvanized**-steel pipe support channels.
5. Pipe Supports: **Roller** or **Strut clamps**.
6. Hardware: **Galvanized** steel.
7. Accessories: Protection pads.
8. Height: **12 inches above roof**.

D. High-Profile, Single-Base, Single-Pipe Stand:

1. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Single vulcanized rubber or molded polypropylene.

3. Vertical Members: Two **galvanized**-steel, continuous-thread, 1/2-inch rods.
4. Horizontal Member: One adjustable-height, g**alvanized-**steel, pipe-support slotted channel or plate.
5. Pipe Supports: **Roller or Clevis hanger**.
6. Hardware: **Galvanized** steel.
7. Accessories: Protection pads**, 1/2-inch, continuous-thread, galvanized-steel rod**.
8. Height: **36 inches above roof**.

E. High-Profile, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: Two or more; **vulcanized rubber** or **molded polypropylene**.

3. Vertical Members: Two or more, **galvanized**-steel channels.
4. Horizontal Members: One or more, adjustable-height, **galvanized**-steel pipe support.
5. Pipe Supports: **Roller or Clevis hanger**.
6. Hardware: **Galvanized** steel.
7. Accessories: Protection pads**, 1/2-inch, continuous-thread rod**.
8. Height: **36 inches above roof**.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.10 PIPE-POSITIONING SYSTEMS

A. Description: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.11 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.12 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus **200 lb**.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.

D. **Metal** or **Fiberglass** Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

E. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

F. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

G. Pipe Stand Installation:

1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

H. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

I. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

L. Install lateral bracing with pipe hangers and supports to prevent swaying.

M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, **NPS 2-1/2** and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.

N. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

P. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment, and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for **trapeze pipe hangers and equipment supports**.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to **1-1/2 inches.**

3.6 PAINTING

A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel **pipe hangers and supports**, m**etal trapeze pipe hangers and metal framing systems** and attachments for general service applications.

F. Use copper-plated pipe hangers and **copper or** s**tainless-steel** attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal hanger-shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction occurs.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction occurs.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

   a. Horizontal (MSS Type 54): Mounted horizontally.
   b. Vertical (MSS Type 55): Mounted vertically.
   c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use **powder-actuated fasteners or mechanical-expansion anchors** instead of building attachments where required in concrete construction.

R. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

ECTION 22 05 53.02

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. Identify by labels and tags the following items:

1. Equipment such as electric water heaters, pumps and similar items.
2. Piping exposed in equipment rooms or accessible service areas.
3. Piping running above accessible ceiling construction.
4. All shock absorbers, whether accessible or not.
5. Trap primers, including description of what floor drains are served.

B. Install laminated plastic nameplates for equipment, and stencils for piping.

C. Install piping identification at MAXIMUM 25 FT. intervals.

D. For piping systems not listed, verify with the Owner.

1.02 ACCEPTABLE MANUFACTURERS

A. Seton “Setmark” or approved equal by Brady, MSI, or Calpico.

PART 2 PRODUCTS

2.01 EQUIPMENT IDENTIFICATION

A. Engraved laminated plastic nameplates, sized for 3/4 in. high letters or numbers, Gothic style.

2.02 PIPING IDENTIFICATION

A. Stencils. Letter size shall be as follows:

OVERALL PIPE/INSULATION SIZE	MINIMUM LETTER HEIGHT
Up to 1-1/4 in. diameter	3/4 in. high
1-1/2 in. to 2 in. diameter	1 in. high
2-1/2 in. to 6 in. diameter	1-1/2 in. high

2.03 IDENTIFICATION SCHEDULE

A. Identify as follows:

TYPE OF SERVICE	BACKGROUND COLOR	TEXT COLOR	DESIGNATION
Domestic Cold Water	Green	White	DCW
Domestic Hot Water (109 deg. F.)	Yellow	Black	DHW-109

TYPE OF SERVICE	COLOR	COLOR	DESIGNATION
Domestic Hot Water (140°F)	Yellow	Black	DHW-140
Domestic Hot Water Return (109°F)	Yellow	Black	DHWR-109
Sanitary	Green	White	SAN
Sanitary Vent	Yellow	Black	V
Gas	Yellow	Black	GAS
Compressed Air	Yellow	Black	AIR
Grease	Yellow	Black	GRS
Hydraulic Oil	Yellow	Black	HYDOIL
Motor Oil (15W40)	Yellow	Black	MO(15W40)
Motor Oil (5W20)	Yellow	Black	MO(5W20)

END OF SECTION 22 05 53.02

SECTION 22 05 54

PLUMBING VALVE TAGGING

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide valve tags on all plumbing valves. EXCEPTION: Valves or stops serving only (1) plumbing fixture need not be tagged. Tags shall be stamped with service designation and numbered consecutively for each system. Attach to valves or as directed by the A/E.

B. Prepare valve tag directory with charts showing locations, designations, and sizes of valves. Laminate under plastic and mount as directed by the A/E. Additional copies of valve charts shall be included in the Operating and Maintenance Manuals.

1.02 ACCEPTABLE MANUFACTURERS

A. Seton, Brady, MSI, or Calpico.

PART 2 PRODUCTS

2.01 TAGS

A. 2 in. diameter, 19 ga., brass tag with brass jack chain. 1/4 in. high stamped letters over 1/2 in. high stamped numbers, both black-filled.

2.02 IDENTIFICATION SCHEDULE

A. Identify as follows:

TYPE OF SERVICE	VALVE TAG DESIGNATION
Water Service	W
Domestic Cold Water	DCW
Domestic Hot Water (109 deg F.)	DHW-109
Domestic Hot Water Return (109 deg F.)	DHWR-109
Gas	GAS
Compressed Air	AIR

END OF SECTION 22 05 54

SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 DESCRIPTION

A. Insulate the following items:

1. Domestic cold water supply, domestic hot water supply and return piping, regardless of length or location.

2. Domestic water supply and waste pipe under all lavatories and sink fixtures accessible to the handicapped.

3. Trap primer drain lines.

4. All sanitary vent piping within 10 ft. of an exterior wall or roof penetration.

B. All exposed insulated piping and fittings, from floor up to 7 ft. 6 in. above floor, shall have a PVC cover applied over pipe insulation and solvent welded together. Material shall be same as PVC fitting covers.

1.02 ACCEPTABLE MANUFACTURERS

A. Owens Corning Fiberglas or approved equal by Schuller, Certainteed, Johns Manville, Armstrong, Rubatex, Imcoa, Manson, or Knauf.

B. Manufacturer and Model Number listed under Part 2 shall be considered to be the Design Base Manufacturer and Model Number. Other Acceptable Manufacturers will be permitted, unless specifically excluded.

1.03 ACTION SUBMITTALS

A. Product data: For each type of product.

PART 2 PRODUCTS

2.01 PIPE INSULATION

A. Indoor Piping: Owens Corning Fiberglas 25 ASJ/SSL/II. 1 piece, heavy duty, fiberglass insulation with all-purpose vapor barrier jacket of white kraft bonded to aluminum foil and reinforced with fiberglass yarn, longitudinal pressure-sensitive tape for sealing of lap joint, 0 deg. F. to 800 deg. F. temperature rating. Insulation thicknesses:

1. Domestic cold water, electric water cooler waste trap, above ground waste and vent, and above ground trap primer piping:

a. 1 in. and smaller: 1/2 in. thick, minimum.

b. 1 1/4 in. and larger: 1 in. thick, minimum.

c. OPTION: 3/4 in. thick fire-rated Armaflex may be used in walls (not in chases).

2. Below-ground trap primer piping: 3/4 in. thick fire-rated Armaflex.

3. Domestic hot water and domestic hot water recirculating piping: 2 in. and smaller: 1 in. thick, minimum.

wall thickness, fire-rated, 220 deg. F. temperature rating. Pipe and joints shall be sealed with Manufacturer's approved adhesive.

1. Acceptable Manufacturers: Armstrong fire-rated "Armaflex," Rubatex, or Imcoa.
2. OPTION: Indoor pipe insulation, listed in Paragraph A above, may be used in walls.

C. Pipe Fittings:

1. Insulation: Owens Corning TIW 1. Wrapped 1 lb. density fiberglass blanket with reinforced foil and kraft vapor barrier facing or molded fiberglass segments with pre-molded, 1 piece PVC plastic covers. Wrapped fiberglass blanket shall be installed to same thickness as pipe insulation.

2. Fitting insulation covers: Pre-molded, 1 piece PVC plastic covers, with maximum 25 Flame Spread and 50 Smoke Developed ratings. Shall be listed and certified for installation in ceiling plenum spaces.

a. Acceptable Manufacturers: Ceelco, Johns Manville, Knauf, Speedline, or Proco.

D. Lavatories Accessible to Handicapped: This applies to P trap and hot and cold water supplies for handicapped lavatories and other lavatories in toilet rooms accessible to the handicapped.

1. Offset P traps and angle stop/supply assemblies shall be insulated with smooth, abrasion-resistant vinyl plastisol exterior cover with 1/8 in. minimum thickness over cushioned foam insert. Attach pipe covering with nylon tie fasteners. Nylon tie fasteners shall remain substantially out of sight.

2. Acceptable Manufacturers: Brocar Trap Wrap Protective Kit 500R, McQuire ProWrap, Truebro Lav Guard, or Plumberex Pro Series.

2.02 PVC JACKET OVER PIPE INSULATION

A. PVC jacket, 1 piece, solvent weld joints.

2.03 MASTICS, ADHESIVES, AND FINISHES

A. Mastics, adhesives, and finishes shall be approved for their intended use by the Insulation Manufacturers.

B. Acceptable Manufacturers: Benjamin Foster, Vimasco, ICC, or Aerobol.

C. Vegetable or wheat paste is prohibited.

2.04 PIPE-INSULATING SUPPORT

A. Piping 1 1/2 in. and Smaller: Provide 12 in. long, 18 ga. galvanized or stainless steel sheet metal half round piping shield inside clevis hanger.

B. Piping 2 in. and Larger: Pre-compressed fiberglass load-bearing segment, integral fire-retardant vapor barrier jacket and saddle.

1. Acceptable Manufacturers: Insul Coustic Co., Insul Shield, or Pipe Shield, Inc.
2.

PART 3 EXECUTION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range of between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

3.03 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles below.

E. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation made from same material and density as that of adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

F. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

G. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

END OF SECTION 22 07 19

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 GENERAL

1.01 DESCRIPTION

A. Connect to water service line above floor slab where shown on Drawings.

B. Contractor shall provide site water service line.

C. Provide a complete system of domestic hot water and cold water piping to fixtures and equipment where shown on Drawings.

D. Sterilize complete domestic water system.

E. Install backflow preventer on domestic water supply line where shown.

F. Provide 3/4 in. valved branches on water service at point of entry into building, just past main backflow preventer and at the beginning of each branch, for injecting chlorine for sterilization.

G. Test complete system.

1.02 ACTION SUBMITTALS

A. Product data.
B. System purging and disinfecting activities report.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Installers of pressure-sealed joints are to be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

PART 2 PRODUCTS

2.01 WATER PIPING

A. Above Ground: Type “L” hard drawn copper tubing with wrought or forged copper solder fittings (ASTM B88). OPTIONS: Copper press fittings or “T Drill” mechanically formed connections, and brazed joints.

B. Piping in Earth and Under Slab:

1. 2 1/2 in. and smaller: Type “K” soft copper (ASTM B88), wrought copper fitting, and brazed joints.

a. Acceptable Manufacturers: Clow “Super Bell-Tite” or approved equal by American Cast Iron Pipe Company or U. S. Pipe & Foundry.

C. Trap Primer Drain Piping: Type “K” soft copper (ASTM B88), wrought copper fitting, and brazed joints.

D. Copper press fittings with smart connect feature shall conform to the material and sizing requirements of ASME B16.18 or B16.22. O rings for copper press fittings shall be of EPDM construction.

welded) low carbon steel tubing, 1010-1020 alloy, annealed soft, 5,000 psig minimum operating pressure. Minimum wall thickness shall be 5/8" – 0.083" wall, ¾" – 0.095" wall, 1"– 0.12 wall. Fittings shall be compatible with the pipe with similar characteristics.

2.02 SOLDER AND BRAZING ALLOYS

A. Solder: 95 5 tin-antimony, lead free.

1. Acceptable Manufacturers: Engelhard "Silvabrite 100," J. W. Harris Co. "Bridgit," or Oatey.

B. Copper Brazing Alloys: Silver/phosphorous or silver/zinc alloys having a melting point greater than 1,000 deg. F. (ANSI B31.1 and AWS A58).

1. Acceptable Manufacturers: Handy Harman Sil Fos, Airco Welding Products Aircosil, or ESAB Allstate.

C. Certify that solder and brazing used for entire piping system is lead-free.

PART 3 EXECUTION

3.01 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings

B. Install copper tubing under building slab in accordance with CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints in accordance with AWWA C600 and AWWA M41.

D. Install underground copper tube and ductile-iron pipe in PE encasement in accordance with ASTM A674 or AWWA C105/A21.5.

E. Install valves in accordance with Section 220523 "General-Duty Valves for Plumbing Piping."

F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

G. Install domestic water piping level without pitch and plumb.

H. Rough-in domestic water piping for water-meter installation in accordance with utility company's requirements.

I. nstall piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

J. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

coordinate with other services occupying that space.

L. Install piping to permit valve servicing.

M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

N. Install piping free of sags and bends.

O. Install fittings for changes in direction and branch connections.

P. Install PEX tube with loop at each change of direction of more than 90 degrees.

Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

R. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in Section 220500 "Common Work Results for Plumbing."

S. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123.21 "Inline, Domestic Water Pumps."

T. Install thermometers on outlet piping from each water heater. Comply with requirements for thermometers in Section 220500 "Common Work Results for Plumbing."

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.02 INSTALLATION OF PIPING

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

copper tube and fittings in accordance with ASTM B828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.

G. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on joint fittings by inserting tube to measured depth.

H. Extruded-Tee Connections: Form tee in copper tube in accordance with ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

I. Joint Construction for Grooved-End Copper Tubing: Make joints in accordance with AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

J. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints in accordance with AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

K. Joint Construction for Grooved-End Steel Piping: Make joints in accordance with AWWA C606. Roll groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

L. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts in accordance with ASME B31.9.

M. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. CPVC Piping: Join in accordance with ASTM D2846/D2846M.
3. PVC Piping: Join in accordance with ASTM D2855.

N. Joints for PEX Tubing, ASTM: Join in accordance with ASTM F1807 for metal insert and copper crimp ring fittings and ASTM F1960 for cold expansion fittings and reinforcing rings.

O. Joints for PEX Tubing, ASSE: Join in accordance with ASSE 1061 for push-fit fittings.

P. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.03 INSTALLATION OF TRANSITION FITTINGS

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

3.04 INSTALLATION OF DIELECTRIC FITTINGS

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flange kits.

D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.05 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

C. Install hangers for copper and stainless steel tube and pipe, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install vinyl-coated hangers for PVC pipe, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Install vinyl-coated hangers for PEX tube, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

F. Support horizontal piping within 12 inches (300 mm) of each fitting.

G. Support vertical runs of copper and stainless steel tube and pipe to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

H. Support vertical runs of PVC pipe to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

I. Support vertical runs of PEX tube to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.06 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.07 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

3.08 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system in accordance with either of the following:

i. Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
ii. Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.09 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.

B. Check plumbing specialties and verify proper settings, adjustments, and operation

3.10 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

c. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after installation and before setting fixtures.
d. Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph and to ensure compliance with requirements.

e. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
f. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.

unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

d. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

e. Hydrostatic testing and documentation of test results for polypropylene (PP-R and PP-RCT) pipe to be in accordance with manufacturer's written instructions and submitted to manufacturer upon successful completion per warranty requirements.

f. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.

g. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 22 11 16

SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide plumbing piping specialties or accessories as shown or required to complete the installation of all plumbing systems installed on this Project.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.03 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 PRODUCTS

2.01 THERMOMETERS

A. Trerice "Industrial Type." Blue reading, organic liquid, 9 in. scale, cast aluminum, epoxy powder-coated case, front double-strength window, straight or adjustable angle pattern, brass separable well, range of 30 deg. F. to 180 deg. F. Provide insulation extension.

B. Other Acceptable Manufacturers: Approved equal by Weiss, Ashcroft, Marsh, Weksler, Winters, or Marshalltown.

2.02 BACKFLOW PREVENTERS

A. BFP 1, 2 1/2 in. and above: Zurn-Wilkins Model 375OSYFSC. Suitable for continuous pressure, inlet and outlet OS&Y gate valves, inlet strainer, test cocks, differential pressure relief valve with ASME A112.1.2 air gap fitting between (2) independently operated check valves. Entire assembly coated inside and outside with FDA-approved epoxy material

B. BFP 2, Brine Maker Water Service: Watts Series 909M1QT-S. Reduced pressure dual checks, inlet and outlet bronze ball valves, with strainer, air gap drain funnel, line size.

C. BFP 5, Ice Machine: Watts Series 7. Continuous pressure type, bronze body, stainless steel springs, double-check valve assembly, FDA approved, 3/8 in. size.

D. Other Acceptable Manufacturers: Approved equal by Ames Co., CMB Industries, Febco Backflow Preventers, Hersey Products, Conbraco Industries, or Watts Regulator Co.

E. Other Acceptable Manufacturers: Approved equal by Ames Co., CMB Industries, Febco Backflow Preventers, Conbraco Industries, or Watts.

F. Refer to Fixture and Equipment Branch Size Schedule on Drawings for sizes and applications.

G. Backflow Preventer Manufacturer and Model shall be on the list of accepted equipment published by the U. S. Public Health Service.

H. Note: Before ordering, obtain approval from the Local Water Utility for the specific type

I. Backflow preventers shall be serviceable without requiring removal from piping.

J. Backflow preventers shall have a permanently attachedplate indicating type and listing approvals.

K. Provide ball valve ahead of strainer on inlet side of backflow preventer assembly.

2.03 SHOCK ABSORBERS

A. Wade "Shokstops." (ASSE Standard 1010, PDI WH201) shock absorbers (water hammer arresters). Sizes as shown on the Drawings.

1. SA A: 3/4 in. pipe. 1 to 11 fixture units.

2. SA B: 1 in. pipe. 12 to 32 fixture units.

3. SA C: 1 in. pipe. 33 to 60 fixture units.

B. Other Acceptable Manufacturers: Approved equal by Zurn, J. R. Smith, Josam, Watts, Sioux Chief, or Precision Products.

C. As an option, air chambers may be used. Size of air chambers shall be (1) size larger than supply line and a minimum of 2 ft. in length.

D. Provide shock absorbers at all locations as required to reduce water hammer.

2.04 STRAINERS

A. Watts Model 777S. 1/2 in. to 3 in., Y pattern, bronze body, threaded, #20 mesh stainless steel screen, 200 PSI WOG.

B. Other Acceptable Manufacturers: Approved equal by Spirax/Sarco, Armstrong, or Hoffman.

2.05 EXTERIOR WALL HYDRANTS

A. WH 1: J. R. Smith "Quarterhorse" Model 5509QT, with bronze faucet face, locking box and cover, freeze resistant faucet, bronze casing, self draining, integral vacuum breaker, 3/4 in. size hose connection, length as required. Provide loose key with each hydrant. (ASSE Standard 1019.)

B. Other Acceptable Manufacturers: Approved equal by Josam, Wade, Woodford, or Zurn.

2.06 INTERIOR HOSE BIBBS

A. HB 1: Watts Model SC 8. Hose bibbs shall have exposed domestic cold water supply, bronze body 3/4 in. NPT male threaded inlet, hex shoulder, tee handle, 3/4 in. male hose threaded outlet.

1. Hose connection vacuum breakers: (ASSE Standard 1011) Watts Model 8A. 3/4 in. hose threaded female inlet x 3/4 in. hose threaded male outlet connection.

2. Other Acceptable Hose Bibb Manufacturers: Approved equal by Chicago Faucet, T & S Brass, or Woodford.

follows:

1. Supply:

   a. Concealed: Nibco #763CL with vacuum breaker on outlet, brass finish.

   b. Exposed: Nibco #74 with vacuum breaker on outlet, brass finish.

   c. Other Acceptable Manufacturers: Approved equal by Chicago Faucet, T & S Brass, Watts, or Woodford.

2.07 TRAP PRIMERS

A. TP 1: Precision Plumbing Products "Prime Rite," Model No. PO 500 (ASSE Standard 1018). Brass housing nonadjustable flow control valve. Provide distribution unit listed below. Units shall adjust automatically to line pressure and flow.

1. Model No. DU 2 for (2) floor drains.

2. Model No. DU 3 for (3) floor drains.

3. Model No. DU 4 for (4) floor drains.

B. Other Acceptable Manufacturers: Approved equal by Mifab, Wade, Watts, or Zurn.

2.08 POST HYDRANT

A. PH 1: J. R. Smith Model 5914 AG. Post-type, freeze-resistant, bronze casing with cast aluminum casing guard, all-bronze interior parts, bronze seat and replaceable seat washer, 2 in. NPT connections, "T" handle operation, 1/8 in. drain port, 2 in. hose outlet, 4 ft. bury. Unit shall be approved by Local Health Department and Ohio EPA.

B. Other Acceptable Manufacturers: Approved equal by Wade, Woodford, or Zurn.

2.09 PRESSURE GAUGES

A. Weiss 4PGA 1. Standard single Bourdon tube, black die cast aluminum case, 4 1/2 in. diameter dial, chrome removable slip ring, gauge cock and pigtail, ±1% accuracy. Range shall be approximately 50% in excess of maximum pressure anticipated. Provide gauge cock.

B. Other Acceptable Manufacturers: Approved equal by Trerice, Marsh, Weksler, Marshalltown, or Ashcroft.

C. Provide spare gauge.

PART 3 EXECUTION

3.01 INSTALLATION OF PIPING SPECIALTIES

A. Backflow Preventers: Install in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.

fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.

3. Do not install bypass piping around backflow preventers.

B. Water Regulators: Install with inlet and outlet shutoff valves. Install pressure gauges on inlet and outlet.

C. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.

D. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install cabinet-type units recessed in or surface mounted on wall as specified.

E. Y-Pattern Strainers: For water, install on incoming water service.

F. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.

G. Supply-Type, Trap-Seal Primer Device: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

H. Drainage-Type, Trap-Seal Primer Device: Install as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

3.02 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.03 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.04 CONTROL CONNECTIONS

A. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.05 IDENTIFICATION

A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Backflow preventers.
2. Water pressure-reducing valves.
3. Balancing valves.
4. Temperature-actuated, water mixing valves.

3.06 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

D. Adjust each reduced-pressure-principle backflow preventer in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

3.07 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections.

1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports

END OF SECTION 22 11 19

SECTION 22 11 24

FACILITY NATURAL GAS PIPING

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide a complete system of interior low-pressure natural gas piping and valves for equipment, and provide final connection. Distribution system pressure shall be 14 in. water column.

B. Connect to outlet of gas meter regulator outside building wall where shown on Drawings, run next to building wall, and enter building at approximately 18 in. above finish floor through waterproof pipe sleeve.

C. Connect to site gas service line 5 ft. outside building foundation wall where shown on Drawings. Provide site gas service line.

D. Extend and connect piping to gas-fired equipment where shown on Drawings.

E. Extend and connect to building gas piping system where shown on Drawings.

F. Provide approved flexible connectors for radiant heaters, back-up generator, and each furnace.

G. Provide equipment gas regulators, if needed, past the shut-off valve.

H. Test complete system.

1.02 ACTION SUBMITTALS

A. Product Data:

- Piping specialties.
- Corrugated, stainless steel tubing with associated components.
- Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
- Pressure regulators. Indicate pressure ratings and capacities.

B. Dielectric fittings.

1.03 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.04 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located

PART 2 PRODUCTS

2.01 GAS PIPING

A. Above Ground and in Building: Standard weight, Schedule 40, welded, plain end, wrought steel pipe and fittings (ANSI B36.10), welded joints with backing rings. Threaded 125 PSI malleable iron fittings are permitted on piping 4 in. and smaller, if less than 5 PSI pressure, except in return air ceiling plenums, and where dropping in walls. Mechanical cold press fittings with EPDM seal are permitted on piping 2-1/2" and smaller, if less than 5 PSI pressure.

B. Optional: Corrugated stainless steel tubing, flexible (ASTM A240), 125 PSI. Maximum operating pressure shall be 5 PSI. Use only fittings associated with corrugated stainless steel tubing.

1. Acceptable Manufacturers: Titeflex "Gastite" or Omegaflex "Tracpipe."

2.02 LUBRICATED PLUG VALVES (SEE OPTION FOR BALL VALVE)

A. 1 in. to 2 in.: 150 lb. SWP (200 lb. WOG), semi-steel body, threaded ends with TFE stem seal and seat, square stem, and permanently attached lever handle.

1. Acceptable Manufacturers: Homestead Fig. 611, Powell Fig. 2200, Rockwell 142, or Nordstrom 142.

B. 2 1/2 in. and Larger: 150 lb. SWP (200 lb. WOG), semi-steel body, flanged ends with TFE stem seal and seat, square stem, wrench-operated. Furnish wrench.

1. Acceptable Manufacturers: Homestead Fig. 612, Powell Fig. 2201, Rockwell 143, or Nordstrom 143.

C. Each type of valve shall be by same Manufacturer.

2.03 BALL VALVES

A. Refer to Section 22 05 23 for acceptable Manufacturers and Model numbers.

2.04 BUTTERFLY VALVES (PERMITTED IN LIEU OF PLUG VALVES 2 IN. AND SMALLER)

A. Milwaukee "Butterball," Model BB2 100. 175 lb. SWP, bronze body, viton seat, threaded ends, stainless steel disc and stem, and lever handle.

B. Other Acceptable Manufacturers: Approved equal by Watts, Apollo, or Nibco.

C. Each type of valve shall be by same Manufacturer.

2.05 PRESSURE REGULATORS (IF NEEDED)

A. (ANSI Z21.18) Sensus. Relief valve and zero governor. Size and capacity as required by equipment.

B. Other Acceptable Manufacturers: American, Emro, or Sprague.

2.06 MECHANICAL COLD PRESS FITTINGS

A. Viega, carbon steel with corrosion-resistant zinc nickel coating, EPDM sealing element, 420 stainless steel grip ring, 304 stainless steel separating ring. Operating pressure 200

B. Other Acceptable Manufacturers: NIBCO, Apollo, Mueller.

PART 3 – EXECUTION

3.01 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping in accordance with the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with the International Fuel Gas Code requirements for preventing accidental ignition.

3.02 INSTALLATION OF OUTDOOR PIPING

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping

B. Install underground, natural-gas piping buried at least 36 inches (900 mm) below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches (900 mm) below finished grade, install it in containment conduit.

C. Install underground, PE, natural-gas piping in accordance with ASTM D2774.

D. Steel Piping with Protective Coating

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

E. Install fittings for changes in direction and branch connections.

F. Install pressure gauge downstream from each service regulator. Pressure gauges are specified in Section 230500 "Common Work Results for HVAC."

3.03 INSTALLATION OF INDOOR PIPING

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Do not install piping in concealed locations unless sleeved with the sleeve open at both ends.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

G. Locate valves for easy access. Do not locate valves within return air plenums.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

Q. Connect branch piping from top or side of horizontal piping.

R. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

S. Do not use natural-gas piping as grounding electrode.

T. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

U. Install pressure gauge downstream from each line regulator. Pressure gauges are specified in Section 230500 "Common Work Results for HVAC."

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC."

3.04 INSTALLATION OF VALVES

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless steel tubing, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

E. Install anode for metallic valves in underground PE piping.
F. Do not install valves in return-air plenums.

3.05 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints in accordance with AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, and then use wrench. Do not overtighten.

G. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join in accordance with ASTM D2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.06 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

C. Install hangers for steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for corrugated stainless steel tubing, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

F. Support vertical runs of steel piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
G. Support vertical runs of corrugated stainless steel tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.07 PIPING CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas-appliance equipment grounding conductor of the circuit powering the appliance in accordance with NFPA 70.

C. Where installing piping adjacent to appliances, allow space for service and maintenance of appliances.
D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

3.08 LABELING AND IDENTIFICATION

A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.
B. Install detectable warning tape directly above gas piping, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.09 FIELD QUALITY CONTROL
A. Tests and Inspections:
1. Test, inspect, and purge natural gas in accordance with the International Fuel Gas Code and authorities having jurisdiction.
2. Natural-gas piping will be considered defective if it does not pass tests and inspections.
B. Prepare test and inspection reports.

3.10 DEMONSTRATION
A. Train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

END OF SECTION 22 11 24

SECTION 221313 - FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless cast-iron soil pipe and fittings.
3. PVC pipe and fittings.
4. Fiberglass pipe and fittings.
5. Concrete pipe and fittings.
6. Nonpressure-type transition couplings.
7. Pressure-type pipe couplings.
8. Cleanouts.
9. Manholes.
10. Concrete.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Pipe and fittings.
2. Non-pressure and pressure couplings
3. Cleanouts.

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of pipe and fitting.

B. Field quality-control reports.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

1.6 FIELD CONDITIONS

A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Construction Manager no fewer than 14 days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Construction Manager written permission.

PART 2 - PRODUCTS

2.1 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A74, Service class

B. Gaskets: ASTM C564, rubber.

C. Calking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A888 or CISPI 301.

B. CISPI-Trademark, Shielded Couplings:

1. Description: ASTM C1277 and CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Shielded Couplings:

1. Description: ASTM C1277 and ASTM C1540, with stainless-steel shield; stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

D. Cast-Iron, Shielded Couplings:

1. Description: ASTM C1277 with ASTM A48/A48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C564, rubber sleeve with integral, center pipe stop.

E. Unshielded Couplings:

1. Description: ASTM C1277 and ASTM C1461, rigid, sleeve-type, reducing- or transition-type mechanical coupling, with integral, center pipe stop, molded from ASTM C1440, thermoplastic elastomer (TPE) material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.3 PVC PIPE AND FITTINGS

A. PVC Gravity Sewer Piping:

1. Pipe and Fittings: ASTM F679, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F477, elastomeric seals for gasketed joints.

2.4 NONPRESSURE-TYPE TRANSITION COUPLINGS

A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling; for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and include corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Cast-Iron Soil Pipes: ASTM C564, rubber.
2. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
3. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:

1. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:

1. Description: ASTM C1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:

1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

F. Nonpressure-Type, Rigid Couplings:

1. Description: ASTM C1461, sleeve-type, reducing- or transition-type mechanical coupling; molded from ASTM C1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.5 PRESSURE-TYPE PIPE COUPLINGS

A. Tubular-Sleeve Couplings: AWWA C219, with center sleeve, gaskets, end rings, and bolt fasteners.

B. Metal, bolted, sleeve-type, reducing or transition coupling; for joining underground pressure piping. Include 150-psig minimum pressure rating and ends of same sizes as piping to be joined.

C. Center-Sleeve Material: Manufacturer's standard

D. Gasket Material: Natural or synthetic rubber.

E. Metal Component Finish: Corrosion-resistant coating or material.

2.6 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.

2. Top-Loading Classification: Medium Duty
3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts:

1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.7 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C923 , cast or fitted into manhole walls, for each pipe connection.

9. Steps: **Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D4101, PP**, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than **60** inches.
10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

2.8 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350, and the following:

1. Cement: ASTM C150/C150M, Type II.
2. Fine Aggregate: ASTM C33/C33M, sand.
3. Coarse Aggregate: ASTM C33/C33M, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
3. Install piping with 36-inch minimum cover.
4. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
5. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
6. Install PVC gravity sewer piping according to ASTM D2321 and ASTM F1668.
7. Install fiberglass sewer piping according to ASTM D3839 and ASTM F1668.

G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping according to the following:

1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
3. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
4. Join PVC gravity sewer piping according to ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasket joints.
5. Join fiberglass sewer piping according to ASTM D4161 for elastomeric-seal joints.
6. Join dissimilar pipe materials with nonpressure-type, flexible or rigid couplings.

3.4 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

C. The specified Manhole shall be installed using conventional backfill materials and procedures. The backfill material shall be crushed stone or other granular material meeting the requirements

of class 1, class 2, or class 3 material as defined in ASTM D2321. Bedding and backfill for surface drainage inlets shall be well placed and compacted uniformly in accordance with ASTM D2321. The drain basin body will be cut at the time of the final grade. No brick, stone or concrete block will be required to set the grate to the final grade height. For load rated installations, a concrete slab shall be poured under and around the grate and frame.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.5 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.6 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.7 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 221316 "Sanitary Waste and Vent Piping."

B. Connect force-main piping to building's sanitary force mains specified in Section 221316 "Sanitary Waste and Vent Piping." Terminate piping where indicated.

C. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

2. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.8 IDENTIFICATION

A. Comply with requirements in Section 312000 "Earth Moving" for underground utility identification devices. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.9 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:

    a. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
    b. Close openings in system and fill with water.
    c. Purge air and refill with water.
    d. Disconnect water supply.
    e. Test and inspect joints for leaks..

6. Manholes: Perform hydraulic test according to ASTM C969.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.10 CLEANING

A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION 221313

SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide a complete system of interior soil, waste, and vent piping to fixtures and equipment, including traps, floor drains and cleanouts. Building drain shall extend to a point 5 ft. beyond the foundation wall, unless otherwise indicated on Drawings.

B. Connect to site sanitary sewer system 5 ft. outside building foundation wall where shown on Drawings. Extend sanitary line into building.

C. "Dead end" sanitary branches longer than 2 ft. 0 in. will not be permitted.

D. Provide oil interceptor.

E. Test complete system.

1.02 ACCEPTABLE MANUFACTURERS

A. Piping and Fittings:

1. Cast iron: Charlotte, Clow, American Cast Iron, Tyler Pipe, U. S. Pipe & Foundry or Griffin.

2. Copper: American Brass Co., Revere, Chase Brass Co. or Nibco.

3. ABS or PVC plastic: Yardley, Nibco, Crestline or Charlotte.

4. Steel: Armco, Republic or Wheeling.

B. Floor Drains and Cleanouts: Zurn, Jay R. Smith, Wade, Josam or Watts.

C. Manufacturer and Model Number listed under Part 2 shall be considered to be the Design Base Manufacturer and Model Number. Other Acceptable Manufacturers will be permitted, unless specifically excluded.

1.03 ACTION SUBMITTALS

A. Product data.

PART 2 PRODUCTS

2.01 PIPING

A. Sanitary, waste, and vent piping and fittings under slab:

1. Extra heavy weight, single hub cast iron (ASTM A74), factory-coated with coal tar enamel.

2. Hubless cast iron (ASTM A74), factory-coated with coal tar enamel.

3. Schedule 40 PVC/DWV plastic (ASTM D2665).

B. Schedule 40 ABS/DWV plastic (ASTM D2661).

C. Interior above-grade sanitary waste piping and fittings:

1. Service weight, single hub cast iron (ASTM A74), factory-coated with coal tar enamel.

2. Hubless cast iron (ASTM A74), factory-coated with coal tar enamel.

3. Copper DWV tube, 4 in. and smaller (ASTM B306): Type L drainage tube, drawn temper.

4. PVC Schedule 40 solid wall pipe according to ASTM D 1784, D 1785, and D 2665. PVC DWV fittings conforming to ASTM D 1784 and D 2665.

D. Interior above-grade vent piping and fittings:

1. Service weight, single hub cast iron (ASTM A74), factory-coated with coal tar enamel.

2. Hubless cast iron (ASTM A74), factory-coated with coal tar enamel.

3. Steel pipe, 2 1/2 in. and smaller (ASTM A53): Type E or S, Grade A or B, Schedule 40, galvanized.

4. Copper DWV tube, 4 in. and smaller (ASTM B306): Type L drainage tube, drawn temper.

5. PVC Schedule 40 solid wall pipe according to ASTM D 1784, D 1785, and D 2665. PVC DWV fittings conforming to ASTM D 1784 and D 2665.

E. Plastic piping is not permitted where it may be vulnerable to physical damage, or where run exposed.

F. Plastic piping shall not be installed in ceiling spaces used for return air plenums. Refer to Architectural and HVAC Drawings for the location of these areas.

G. Any exposed vent piping shall be galvanized steel.

2.02 JOINTS

A. Cast Iron:

1. Tarred jute or oakum with lead poured flush with hub.

2. (ASTM C 564) Compression-type plastic seal.

3. Joints in hubless cast iron pipe sizes 1 1/2 in. to 10 in. shall be made with coupling approved to FMG 1680 Class 1 and marked with the logo. Couplings shall be Clamp All Corporation Model #80, for pipe sizes 1 1/2 in. to 4 in., Model #125 pipe sizes 5 in. to 10 in.

4. Joints in hubless cast iron pipe sizes 1 1/2 in. to 2 in. where exposure to head pressure cannot exceed 10 ft. shall be approved to CISPI Standard 310 85. Couplings shall be

B. Copper: Cast (ASTM B16.23) or wrought (ASTM B16.29) copper drainage fittings with solder joints.

D. All fittings shall be compatible with piping for size, material, and joint type.

E. Cast iron pipe and fittings shall be factory-coated with coal tar enamel.

2.03 FLOOR DRAINS

A. Drains shall be adjustable, coated cast iron double drainage pattern, bottom outlet, flashing clamp, strainers, sediment buckets, and with other accessories and features as noted below.

B. Each floor drain grate that has a load rating shall have an ANSI load rating indicated on shop drawings. If rating is not indicated on shop drawings, they will be rejected.

C. Each floor drain that is required to have a secured grate shall have at least (3) screws for attachment of grate.

D. Slot in grates shall be free of flashing (clean cut), and tops shall not have sharp edges that may be injurious to bare feet.

E. FD 1: Zurn #Z415 P VP. Cast iron body, adjustable, 5 in. diameter Type B strainer, secured, nikaloy finish, nickel/bronze strainer, caulk or push-on outlet, 3 in. or 4 in. pipe size, as noted, and 3/4 in. trap primer connection. Provide vandal-resistant screws on strainer.

F. FD 2: Zurn #Z550 P DG. Cast iron body, adjustable, 9 in. diameter Type B strainer, secured, medium-duty load rating, nickel/bronze strainer, caulk or push-on outlet, 3 in. or 4 in. pipe size, as noted, and 3/4 in. trap primer connection.

G. FD 3: Zurn #Z415 P VP-4. Cast iron body, adjustable, 5 in. diameter Type B strainer, secured, nikaloy finish, nickel/bronze strainer with 4-in. dia. funnel, caulk or push-on outlet, 3 in. or 4 in. pipe size, as noted, and 3/4 in. trap primer connection where indicated. Provide vandal-resistant screws on strainer.

H. FD 4: Zurn model as specified on drawings.

2.04 CLEANOUTS

A. All cleanouts shall be line size (6 in. size on 6 in. or larger line) and installed in accessible locations.

B. Provide membrane clamps on all cleanouts in floors having waterproofing membrane.

C. Floor Cleanouts: Each floor cleanout shall have an ANSI load rating indicated on shop drawings. If rating is not indicated on shop drawings, they will be rejected. Each floor cleanout that is required to have a vandal resistant top shall have at least (3) screws for attachment to top.

1. Floors with ceramic tile finish: Zurn #ZN1400 VP. Adjustable cast iron body, heavy- duty load rating, vandal resistant, round, nickel/bronze scoriated cover, ABS plastic plug, line size, and caulk or push-on outlet.

2. Floors with vinyl tile finish: Zurn #ZN1400 VP. Adjustable cast iron body, heavy-duty load rating, vandal-resistant, round, nickel/bronze cover, ABS plastic plug, line size, and caulk or push-on outlet.

rating, vandal-resistant cast iron scoriated cover, threaded ABS plastic plug, line size, and caulk or push-on outlet.

4. Vehicular traffic: Zurn #Z1400 HD VP. Adjustable cast iron body, heavy-duty load rating, vandal-resistant cast iron scoriated cover, threaded ABS plastic plug, line size, and caulk or push-on outlet.

D. Wall Cleanouts: Zurn #ZS1469 VP. Round polished stainless steel access cover, and vandal-resistant screw.

E. Exterior Cleanouts: Zurn #Z1400 HD VP. Adjustable cast iron body, heavy-duty load rating, vandal-resistant cast iron scoriated cover, threaded ABS plastic plug, line size, and caulk or push-on outlet.

2.05 VENT FLASHING

A. Provide roof vent boots and flashing.

PART 3 EXECUTION

I.01 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

I.02 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

flow is from horizontal to vertical.

2. Use long-turn, double Y-branch, and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.

3. Straight tees, elbows, and crosses may be used on vent lines.

4. Do not change direction of flow more than 90 degrees.
5. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

    a. Reducing size of waste piping in direction of flow is prohibited.

K. Lay buried building waste piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: Two percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
2. Horizontal Sanitary Waste Piping: One percent downward in direction of flow.
3. Vent Piping: One half percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

N. Install aboveground ABS piping in accordance with ASTM D2661.

O. Install aboveground PVC piping in accordance with ASTM D2665.

P. Install underground PVC piping in accordance with ASTM D2321.

Q. Plumbing Specialties:

1. Install backwater valves in sanitary waster gravity-flow piping.

    a. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."

2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

    a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
    b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."

3. Install drains in sanitary waste gravity-flow piping.

    a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

having jurisdiction.

S. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

T. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

I.03 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints:

1. Join hubless, cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendixes.
3. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendixes.

E. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:

a. Provide axial restraint for pipe and fittings 5 inches (125 mm) and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
b. Provide rigid sway bracing for pipe and fittings 4 inches (100 mm) and larger, upstream and downstream of all changes in direction 45 degrees and greater.

F. Provide rigid sway bracing for pipe and fittings 5 inches (125 mm) and larger, upstream and downstream of all changes in direction and branch openings.

I.04 INSTALLATION OF SPECIALTY PIPE FITTING

A. Transition Couplings:

B. In Waste Drainage Piping: Shielded, nonpressure transition couplings

I.05 INSTALLATION OF VALVES

A. General valve installation requirements for general-duty valve installation are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install full-port ball valve for piping NPS 2 (DN 50) and smaller.
2. Install gate valve for piping NPS 2-1/2 (DN 65) and larger.

I.06 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment"

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42 clamps.
6. Install individual, straight, horizontal piping runs:

a. 100 Ft. (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
b. Longer Than 100 Ft. (30 m): MSS Type 43, adjustable roller hangers.
c. Longer Than 100 Ft. (30 m) if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Ft. (30 m) or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52 spring hangers.

C. Install hangers for cast-iron soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting, valve, and coupling.

F. Support vertical runs of cast-iron soil piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support vertical runs of PVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

I.07 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Comply with requirements for cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
6. Equipment: Connect waste piping as indicated.

a. Provide shutoff valve if indicated and union for each connection.
b. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections in accordance with the following unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

I.08 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

I.09 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

a. Close openings in piping system and fill with water to point of overflow, but not less than 10 ft. head of water (30 kPa head of water).
b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1 inch wg (250 Pa).
b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
c. Air pressure must remain constant without introducing additional air throughout period of inspection.
d. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

I.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.
E. Repair damage to adjacent materials caused by waste and vent piping installation.

END OF SECTION 22 13
16

SECTION 22 13 23

OIL INTERCEPTORS

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide a sanitary sewer system from building to oil interceptor where shown on Drawings, complete with piping and exterior cleanouts.

B. Provide two oil interceptors as shown on drawings – one shall serve the Truck Storage, Office Maintenance building, and Mix building, the other oil interceptor shall serve the gasoline fueling station area.

C. Test complete system.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of interceptor. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.

1.03 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

- Piping connections. Include size, location, and elevation of each.
- Interface with underground structures and utility services.

1.04 CLOSEOUT SUBMITTALS

- Operation and Maintenance Data: For sanitary waste interceptors to include in emergency, operation, and maintenance manuals.

1.05

PART 2 PRODUCTS

2.01 GRAVITY SEWER PIPE

A. Under sodden areas or non-traffic areas, use the following:

1. Cast iron sewer pipe:

a. Service weight (ASTM A74) with oakum and lead or compression seal gasket joints.

b. Hubless (ASTM A74 and CISPI 301) with stainless steel couplings or cast iron Alfa or MG couplings.

a. PVC plastic (ASTM D3034), SDR 35 with (ASTM 3212) seals.

b. ABS plastic (ASTM D2751).

B. All fittings shall be compatible with piping for size, material, and joint type.

C. Cast iron pipe and fittings shall be factory-coated with coal tar enamel.

2.02 OIL INTERCEPTOR

A. Provide Proceptor Model OMC 1500. Glass-fiber with an isothalic resin, complete with tappings, vents, manhole extension(s) to finished grade, single tank, 1,500 gallons total capacity, drain 30,000 sq. ft. of floor area minimum, 1 cu. ft. minimum liquid capacity above outlet for each 100 sq. ft. of floor area to be drained into interceptor. 30 year warranty.

B. Proceptor Model HIS 101. Gasketed cast iron frames and covers.

C. Interceptor shall comply with County and State requirements.

D. Other Acceptable Manufacturers: Approved equal by Containment Solutions, Inc., or Xerxes.

2.03 EXTERIOR CLEANOUTS

A. Zurn #Z 1400 HD. Adjustable cast iron body, heavy-duty load rating, cast iron vandal-resistant scoriated cover, threaded ABS plug, line size, caulk outlet.

B. Other Acceptable Manufacturers: Approved equal by Wade, Jay R. Smith, Josam, or Ancon.

2.04 TAPE COATING

A. Install with 1/2 in. minimum overlap.

B. Acceptable Manufacturers: Tapecoat Co. “Tapecoat CT,” Kendall Co. “Polyken 930,” Royston Labs “Greenline,” or Republic Steel “X Tru Tape #35.”

PART 3 EXECUTION

1.01 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving.

1.02 INSTALLATION

A. Install Oil Interceptor per manufacturer’s installation instructions.

A. Piping installation requirements are specified in Section 221316 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Make piping connections between interceptors and piping systems.

1.04 INDENTIFICATION

C. Identification materials and installation are specified in Section 312000 "Earth Moving."

1. Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.
2. Use warning tapes or detectable warning tape over ferrous piping.
3. Use detectable warning tape over nonferrous piping and over edges of underground structures.

D. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1.05 PROTECTION

A. Protect sanitary waste interceptors from damage during construction period.

B. Repair damage to adjacent materials caused by sanitary waste interceptor installation.

END OF SECTION 22 13 23

SECTION 22 15 13

GENERAL SERVICE COMPRESSED AIR PIPING

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide a complete air distribution system, including outlets, piping, and specialties. Connect to air dryer outlet.

B. Connect to air-operated equipment where shown on Drawings.

C. Distribution air pressure shall be 140 PSIG. Confirm exact distribution air pressure with the Owner.

D. Provide shut-off valve and quick disconnects on airline drops where shown on Drawings.

E. Confirm exact location of air drops, configurations, valve locations, and quick disconnect size and type with the Owner before installation.

F. Test complete system.

1.02 ACTION SUBMITTALS

A. Product Data:

- Plastic pipes, fittings, and valves.
- Dielectric fittings.
- Flexible pipe connectors.
- Safety valves.
- Pressure regulators. Include rated capacities and operating characteristics.
- Automatic drain valves.
- Filters. Include rated capacities and operating characteristics.
- Quick couplings.
- Hose assemblies.

PART 2 PRODUCTS

2.01 AIR PIPING

A. Type “L” hard drawn copper tubing with wrought copper fittings (ASTM B88). OPTION: “T Drill” mechanically formed connections, brazed joints.

B. Schedule 40 black steel (ASTM A53CW): 2 in. and smaller: 150 lb. malleable iron threaded fittings (ASTM A47).

2.02 SOLDER AND BRAZING ALLOYS

A. Solder: 95 5 Tin-Antimony (ASTM B32).

greater than 1,000 deg. F. (ANSI B 31.1).

1. Sil Fos filler as manufactured by Handy Harmon.

2. Aircosil filler as manufactured by Airco Welding Products.

3. Stay Silv filler as manufactured by Harris.

2.03 VALVES

A. Ball Valves, 2 in. and smaller: Milwaukee "Butterball" Model BB2 100 or BB2 350. 150 lb. SWP, bronze body, Viton seat, threaded or solder joint ends, full port, stainless steel disc and stem, and lever handle.

B. Check Valves, 2 in. and smaller: Nibco No. T 413 or S 413. 200 lb. WOG, bronze body, horizontal swing, and threaded or solder joint ends.

C. Other Acceptable Manufacturers: Approved equal by Nibco, Jenkins, Apollo, Keystone, Powell, Crane, Lunkenheimer, Milwaukee, Walworth, or Watts.

D. Each type valve shall be by same Manufacturer.

2.04 CENTRIFUGAL SEPARATOR

A. Kaeser Model KFS 60. High-efficiency in-line separator with separator core and glass fiber filter.

2.05 AIR DRIP TRAPS

A. Armstrong No. 71 A. Snap-action, 3/4 in. connection.

B. Other Acceptable Manufacturer: Approved equal by Spirax/Sarco or Hoffman.

2.06 REGULATORS

A. 3/4 in.: Aro Model 27354 200. Adjustable 10 PSI to 250 PSI range. Aro Model 29077: L type mounting bracket (where required).

B. Pressure gauge: Aro Model 100083. 0 PSI to 300 PSI range.

C. Install filter upstream of regulator.

D. Other Acceptable Manufacturers: Approved equal by Arco, Honeywell Braukmann, A. W. Cash, Cla Val Co., Parker Hannifin, Lincoln, Wilkerson, Wilkins or Graco.

2.07 FILTERS

A. 3/4 in.: Aro Model 25351 221. 10 oz. plastic bowl with guard, automatic mechanical drain, and 5 micron filter element.

B. Other Acceptable Manufacturers: Approved equal by Arco, Balcrank, Hankison, Parker Hannifin, Lincoln, Milton, or Wilkerson.

2.08 OIL LUBRICATORS

A. 3/4 in.: Aro Model L26451 110. 32 oz. oil capacity metal bowl with sight glass, and 190 SCFM air flow rating at 90 PSIG.

B. Other Acceptable Manufacturers: Approved equal by Arco, Balcrank, Parker Hannifin, Lincoln, Milton, Wilkerson or Graco.

2.09 OPTION TO FURNISHING SEPARATE ITEMS: FILTER / REGULATOR / LUBRICATORS

A. 3/4 in.: Aro Model 28358. Pre-assembled filter, regulator, lubricator, and pipe nipple for end-of-line installations.

2.10 FLEXIBLE CONNECTORS

A. Flexonics 401M Series. Stainless steel hose and braid, 250 deg. F. rating, threaded or solder ends, and flange ends where required.

B. Other Acceptable Manufacturers: Approved equal by Anaconda, Keflex, Metraflex, Proco or Graco.

2.11 QUICK COUPLERS

A. Parker 20 Series, Model 25 F. Steel, 1/2 in. female pipe thread, 3/8 in. body. Verify body size and type with the Owner before ordering. Provide (1) companion male quick coupler per female quick coupler to the Owner.

1. Other Acceptable Manufacturers: Approved equal by Aero, Aeroquip, Aro, Balcrank, Breco, Dyna Quip, Foster, Hansen, Hoffman, Lincoln, Milton, Schrader or Graco.

2.12 STRAINERS

A. Y Pattern: Armstrong No. AISC. Semisteel body, stainless steel screen, and threaded ends. Provide drain valve on strainer.

B. Basket: Armstrong. Bronze body, Monel screen, and threaded ends. Provide drain valve on strainer.

C. Other Acceptable Manufacturers: Anderson, Crane, Wilkins, Spirax/Sarco, or Watts.

PART 3 EXECUTION

3.01 INSTALLATION OF PIPING

A. Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.

B. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless otherwise indicated.

coordinate with other services occupying that space.

D. Where installing piping adjacent to equipment and machines, allow space for service and maintenance.

E. Install air and drain piping with 1 percent slope downward in direction of flow.

F. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating unless otherwise indicated.

G. Equipment and Specialty Flanged Connections:

1. Use steel companion flange with gasket for connection to steel pipe.
2. Use cast-copper-alloy companion flange with gasket and brazed or soldered joint for connection to copper tube. Do not use soldered joints for connection to air compressors or to equipment or machines producing shock or vibration.

H. Extended-tee outlets with brazed branch connection may be used for copper tubing, within extruded-tee connection diameter to run tube diameter ratio for tube type, in accordance with Extruded Tee Connections Sizes and Wall Thickness for Copper Tube (Inches) Table in ASTM F2014.

I. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

J. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

K. Install pressure gauge on discharge piping from each air compressor and on each receiver. Comply with requirements in Section 220500 "Common Work Results for Plumbing."

L. Install piping to permit valve servicing.

M. Install piping free of sags and bends.

N. Install fittings for changes in direction and branch connections.

O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.02 INSTALLATION OF SPECIALTIES

A. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.

B. Install air-main pressure regulators in compressed-air piping at or near air compressors.

C. Install air-line pressure regulators in branch piping to equipment and tools.

coalescing filters. Mount on wall at locations indicated.

E. Install quick couplings at piping terminals for hose connections.

F. Install hose assemblies at hose connections.

G. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.

3.03 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for hangers, supports, and anchor devices.

B. Install hangers for copper tubing and steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Install hangers for aluminum piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.

E. Support vertical runs of copper tubing and steel piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

F. Support vertical runs of aluminum piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Individual, Straight, Horizontal Piping Runs:

1. 100 Ft. (30 m) or Less: MSS Type 1, adjustable, steel clevis hangers.
2. Longer Than 100 Ft. (30 m): MSS Type 43, adjustable roller hangers.

H. Multiple, Straight, Horizontal Piping Runs 100 Ft. (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

I. Base of Vertical Piping: MSS Type 52, spring hangers.

3.04 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment."

3.05 FIELD QUALITY CONTROL

A. Perform field tests and inspections.

B. Tests and Inspections:

1. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig (345 kPa) above system operating pressure, but not less than 150 psig (1035 kPa)

system, if required, to test pressure; hold for two hours with no drop in pressure.

2. Piping Leak Tests for Aluminum Compressed-Air Piping: Test new piping system and modified parts of existing piping system. Cap and fill general-service compressed-air piping system to pressure of 15 psig (105 kPa), hold pressure for 10 minutes. Repeat until reaching required operating pressure, not to exceed 220 psig (1515 kPa). Once desired operating pressure is met, let stand for one hour.
3. Repair leaks and retest until no leaks exist.
4. Inspect filters and pressure regulators for proper operation.

C. Prepare test and inspection reports.

END OF SECTION 22 15 13

SECTION 22 15 19

GENERAL SERVICE PACKAGED AIR COMPRESSORS AND RECEIVERS

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide an air compressor and refrigerated air dryer where shown on Drawings.

1.02 ACTION SUBMITTALS

A. Product Data
B. Product Data submittals.
C. Shop Drawings

1.03 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.04 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written instructions for delivery, storage, and handling.

PART 2 PRODUCTS

2.01 AIR COMPRESSOR

A. AC 1: Champion Model VR15F 12. 2 cylinder, 15 HP motor, 208 volts, 3 phase, 1,045 RPM, 49.0 CFM at 175 PSI delivery, 120 gallon vertical ASME receiver tank, complete with compressor, motor, and accessories.

1. Accessories:

a. Air-cooled after-cooler.

b. Air intake silencer-filter.

c. Full-time low oil level shutoff control with manual reset to prevent restarting while oil is being added.

d. OSHA-approved, totally enclosed belt guard.

e. Compressor-mounted magnetic starter with thermal overload protection.

f. Relay and 120 volt coil for wall-mounted pilot switch.

g. Pressure switch. Set pressure switch for 140 PSI.

2. Other Acceptable Manufacturers: Ingersoll-Rand or Emglo.

2.02 AIR DRYER

A. AD 1: Champion Model CRN75, 75 SCFM at 100 PSI at 100 deg. F., 33 in. high x 25 in. wide x 26 in. deep, 1/3 HP, 120 volts, heat/sink cycling type, refrigerated model, self-contained starter controls, air-cooled dryer with pre-cooler, re-heater, air-to-refrigerant heat exchanger, water separator, automatic drain, compressor, condenser, regulator, refrigerant receiver, sight glass, high-pressure refrigerant cutoff, on-off switch, automatic condensate trap, power-on light, outlet air pressure gauges, automatic start-stop control, inlet and outlet air temperature gauge, high- temperature warning light, ambient air filters, and wall-mounted.

B. Other Acceptable Manufacturers: Approved equal by General Air, Hankison, Kahn, Kel Air, Kellog-American, Pure Air, Nash, Van-Air, Wilkerson, or Worthington.

PART 3 EXECUTION

3.01 INSTALLATION OF EQUIPMENT

A. Examine roughing-in of compressed air piping to verify actual location before air compressor installation.

B. Equipment Mounting

1. Install air compressors and air dryers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

C. Install compressed-air equipment anchored to substrate.

D. Arrange equipment so controls and devices are accessible for servicing.

E. Maintain manufacturer's recommended clearances for service and maintenance.

F. Install the following devices on compressed-air equipment:

1. Thermometer, Pressure Gauge, and Safety Valve: Install on each compressed-air receiver.
2. Pressure Regulators: Install downstream from air compressors and dryers.
3. Automatic Drain Valves: Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

3.02 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221513 "General-Service Compressed-Air Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.03 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection
    a. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
    b. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

3.04 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.
B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.05 IDENTIFICATION

A. Identify general-service air compressors and components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.06 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

    a. Complete installation and startup checks in accordance with manufacturer's written instructions.
    b. Check for lubricating oil in lubricated-type equipment.
    c. Check belt drives for proper tension.
    d. Verify that air compressor inlet filters and piping are clear.
    e. Check for equipment vibration-control supports and flexible pipe connectors, and verify that equipment is properly attached to substrate.
    f. Check safety valves for correct settings. Ensure that settings are higher than air compressor discharge pressure, but not higher than rating of system components.
    g. Drain receiver tanks.
    h. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
    i. Test and adjust controls and safeties.

3.07 ADJUSTING

A. Adjust equipment to function smoothly and lubricate as recommend by the manufacturer.
B. Adjust control set points.

3.08 FIELD QUALITY CONTROL

A. Test Agency: Owner will engage a qualified testing agency to perform tests and inspections.
B. Tests and Inspections:

a. Perform each visual and mechanical inspection.
b. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
c. Operational Test: After electrical circuity has been energized, start unit to confirm proper motor rotation and unit operation.
d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
e. Air compressors, aftercoolers, air dryers, and controllers will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.09 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air compressors and air dryers.

END OF SECTION 22 15 19

443

SECTION 22 33 33

GAS FIRED WATER HEATER

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide gas fired tank type water heater including accessories listed in this specification and as necessary for proper operation of system.

B. Install per manufacturer's recommendations.

1.02 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including storage tank and supports.

b. Faulty operation of controls.

c. Deterioration of metals, metal finishes, and other materials beyond normal use.

d.

B. Warranty Period(s): 5 years from date of Substantial

Completion

1.03 ACTION SUBMITTALS

A. Product data: for each type of product

PART 2 PRODUCTS

2.01 WATER HEATER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers:

a. Lochinvar Corporation.

b. PVI Industries, LLC.

c. Rheem Water Heater Div.; Rheem Manufacturing Company.

d. Ruud Water Heater Div.; Rheem Manufacturing Company.

e. Smith, A. O. Water Products Company.

B. Storage-Tank Construction: ASME Code steel with 150-psig working-pressure rating.

a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.

2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

1. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets

2. Factory-Installed, Storage-Tank Appurtenances:

b. Anode Rod: Replaceable magnesium.

c. Dip Tube: Provide unless cold-water inlet is near bottom of tank.

d. Drain Valve: Corrosion-resistant ball valve complying with ASSE 1005.

e. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.

f. Jacket: Steel with enameled finish.

g. Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working- pressure rating. Select one relief valve with sensing element that extends into storage tank.

3. Burner and Heat Exchanger: Comply with UL 795 for high efficiency water heaters and for natural-gas fuel.

4. Temperature Control: Adjustable thermostat.

C. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems

2.02 THERMAL EXPANSION TANKS

A. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air - to minimum system-operating pressure at tank.

1. Manufacturers:

a. AMTROL Inc.

b. Armstrong Pumps, Inc.

c. Taco, Inc.

d. Watts Regulator Co.

e. Wessels Co.

2. Construction:

a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.

b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

c. Air-Charging Valve: Factory installed.

3. Capacity and Characteristics:

a. Working-Pressure Rating: 150 psig.

b. Air Pre-charge Pressure: 40 psig.

c. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.

2.03 WATER HEATER ACCESSORIES

A. Gas Shutoff Valves: ANSI Z21.15/CGA 9.1, manually operated. Furnish for installation in piping.

B. Gas Pressure Regulators: ANSI Z21.18, appliance type. Include pressure rating, capacity, and pressure differential required between gas supply and water heater.

C. Gas Automatic Valves: ANSI Z21.21, appliance, electrically operated, on-off automatic valve.

D. Water Heater Stands: Water heater manufacturer's factory-fabricated steel stand for floor mounting and capable of supporting water heater and water. Provide dimension that will support bottom of water heater a minimum of 18 inches above the floor.

E. Drain Pans: Corrosion-resistant metal with raised edge. Provide dimensions not less than base of water heater and include drain outlet not less than NPS 3/4.

F. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA
90.1 or ASHRAE 90.2.

PART 3 EXECUTION

3.01 INSTALLATION OF DOMESTIC-WATER HEATER

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
2. Maintain manufacturer's recommended clearances.
3. Arrange units so controls and devices that require servicing are accessible.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.

5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Install anchor bolts to elevations required for proper attachment to supported equipment.
8. Anchor domestic-water heaters to substrate.

B. Install domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."

C. Install gas-fired, domestic-water heaters in accordance with NFPA 54.

1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 231123 "Facility Natural-Gas Piping."

D. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install combination temperature-and-pressure relief valves in water piping for domestic-water heaters without storage. Extend domestic-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

F. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

G. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

H. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet. Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing Piping" and comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

I. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

J. Fill domestic-water heaters with water.

K. Charge domestic-water expansion tanks with air to required system pressure.

L. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.

M. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.02 PIPING CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."

B. Comply with requirements for fuel-oil piping specified in Section 231113 "Facility Fuel-Oil Piping."

C. Comply with requirements for gas piping specified in Section 231123 "Facility Natural-Gas Piping."

D. Drawings indicate general arrangement of piping, fittings, and specialties.

E. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.03 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.04 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage, domestic-water heaters. Training shall be a minimum of one hour(s).

END OF SECTION 22 33 33

SECTION 22 42 00

COMMERCIAL PLUMBING FIXTURES

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide plumbing fixtures installed in place, complete with supports, supply, and waste trim as indicated on the Drawings.

B. All fixtures shall have vandal-resistant handles, aerators, escutcheons, carriers, nuts, and bolts.

C. All trim and exposed piping shall be chrome-plated, unless noted otherwise.

D. Faucets shall have ceramic disc valve cartridges or cam activated diaphragm valve cartridges.

E. Exposed metal parts shall be nonferrous and chrome-plated, unless otherwise noted. Vitreous china or enamel fixtures and trim shall be free of defects. Plumbing fixtures shall be white in color, unless otherwise noted.

F. All plumbing fixtures shall be of commercial quality and free of defects.

G. Provide trim, fittings, carriers, angle stops, chrome water supply piping, and all accessories required for a complete installation.

H. Fixture connection sizes are shown on Drawings.

I. All vitreous china plumbing fixtures resting against a wall or floor shall have ground mating surfaces and shall be caulked with silicone sealant of a color to match the fixture. Remove excess material after fixture installation.

J. Provide a 1/4 in. bead of caulk or silicone sealant around the perimeter of casework openings for all countertop fixtures. Remove excess material after fixture installation.

K. Water closet flush valve handle shall be left handed operation, unless required to be right-handed operation to comply with ADA Guidelines. Flush valve trip lever shall be mounted on the wide side of the water closet stall.

1.02 ACTION SUBMITTALS

A. Product Data
B. Product Data submittals.
C. Shop Drawings

1.03 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written instructions for delivery, storage, and handling.

PART 2 PRODUCTS

2.01 PLUMBING FIXTURES AND ACCESSORIES

1. Vitreous China Fixtures: American Standard, Kohler, Eljer, or Crane.

2. Urinal: Sloan, Kohler, or American Standard.

3. Wash fountain: Bradley, Acorn Sanispray, Intersan, or Willoughby.

4. Food Waste Grinder: In-Sink-Erator, Hobart, Kitchen-Aid, Waste King, or Master.

5. Mop Service Basin: American Standard, Fiat, Powers, Standard Elsmere, Stern Williams, Mustee, Florestone, Swan, Creative Industries, Zurn, or Ceco.

6. Sinks: Elkay, Just, American Standard, Mustee.

B. Acceptable Accessory Manufacturers:

1. Flush Valves (with vandal-resistant stop): Sloan, Delany, or Zurn.

2. Water Closet Seats: Beneke, Church, Kohler, Bemis, Olsonite, Centoco, or Sperzel.

3. Faucets: Chicago Faucet, American Standard, Elkay, Kohler, Eljer, Crane, T & S Brass Company, Grohe, Speakman, Moen, Zurn, Delta, Sloan, or Symmons.

4. Supplies, Escutcheons, and Traps: Brasscraft, Bridgeport, Consolidated, Frost, Waterway, McGuire Mfg. Co., Dearborn, Sanitary-Dash, Speedway, Zurn, or Anso-Flex.

2.02 CARRIERS

A. All carriers shall be specifically chosen to accommodate the particular brand and style of fixture actually installed, the particular type of floor and wall actually present at each fixture location, and the piping arrangement at each fixture. Furnish plastic or metal positioning frames to isolate carrier bolts from wall construction.

B. Provide a heavy-duty, rectangular vertical support, floor-supported, commercial type fixture carrier for each wall-mounted plumbing fixture, unless noted otherwise.

C. Water Closets: Zurn Model Z1203 or Z1204. Floor-supported, with buttress foot and foot anchor, rear foot support, flush valve supply support, cast iron, commercial type. Coordinate location of carrier closely with the A/E.

D. Urinals: Heavy-duty type Zurn Model Z1222.

E. Other Acceptable Manufacturers: Approved equal by Jay R. Smith, Wade, or Josam.

2.03 SINK

A. SK 1: Elkay “Lustertone,” Model LR 3319. Countertop, 18 ga. stainless steel, 33 in. x 19 1/2 in. x 6.5 in. deep, double compartment, each 14 in. x 14 in. x 6.5 in. deep, 3 hole punching, #3 finish, and undersides fully undercoated.

1. Faucet: American standard model 7231. Brass gooseneck spout, 2.2 GPM aerator, and chrome water supply piping with wheel angle stops.

2. Food waste grinder: In-Sink-Erator Model PRO ES. Install in drain opening in left compartment. Stainless steel grinding chamber, sound-insulated, stainless steel shredder and impeller, overload protection, 3/4 HP, 120 volts, listed and labeled by

3. Drain: Elkay Model LK 35. Strainer, 1 1/2 in. chrome 17 ga. tailpiece, chrome cast brass trap with cleanout plug, and chrome 17 ga. drain to wall.

4. Escutcheon plates: Chrome metal supply and waste.

5. Coordinate size of sink with the Casework Contractor before ordering sink. Install sink in countertop and casework.

B. SK-2: Mustee model 19F ULTRATUB. Floor mounted, vitreous china, 20 in. x 24 in. x 14 in. deep, single bowl, 3 hole punching, 4” centerset, one piece molded construction using structural thermoplastics with matched meatal molds under extreme heat and pressure. Tub to include integrally molded drain assembly for connection to standard 1-1/2” P trap. Include stopper, wall mounting hardware, heavy gauge steel legs with built-in leveler. Shall meet ANSI specification Z 124.6. Color: white.

1. Faucet: Mustee model 93.600, Chrome finish, 4” center set brass faucet. 6” swing spout with aerator, level handles, replaceable seats and stems.

2.04 WATER CLOSETS

A. WC 1 (wall-mounted, flush valve, back outlet): American Standard “Afwall,” Model 3351.001. Low consumption, 1.6 GPF, siphon jet, elongated bowl, vitreous china, and 1 1/2 in. topspud.

1. Seat: American Standard 5901.100. Commercial-grade, open front, extra heavy-duty, solid white, flame-retardant polypropylene plastic, with self-sustaining check hinge, integral molded bumper, and no cover.

2. Flush valve: American standard 6047.161.002. Chrome with 1 in. screwdriver angle stop, adjustable tailpiece, vacuum breaker, and chrome metal escutcheon plate.

3. Carrier: Provide adjustable carriers for battery of closets, fixed for single closets. Vandal-resistant trim on carrier.

B. WC 2: (ADA-compliant, floor-mounted, flush valve, back outlet): American Standard Model 3695.001, low consumption, 1.6 GPF, siphon jet, elongated bowl, vitreous china, with bolt caps, and 1-1/2 in. top spud.

1. Seat: American Standard 5901.110. Commercial-grade, open front, extra heavy-duty, solid white, flame-retardant polypropylene plastic, with self-sustaining check hinge, integral molded bumper, and no cover.

2. Flush valve: American standard model 6047.161.002. Chrome with 1 in. screwdriver angle stop, Dual-Flush, adjustable tailpiece, vacuum breaker, and chrome metal escutcheon plate.

a. Shorten flush valve outlet tube to allow clearance under grab bar forflush valve servicing.

b. Conform to ADA Accessibility Guidelines concerning location of flush valve trip lever.

3. Carrier: Provide heavy duty carrier. Install at handicapped height.

2.05 URINALS

A. UR 1 (ADA-compliant, wall-mounted, back outlet): American standard 6501.010. Vitreous china, 2 in. back outlet. ¾” top inlet spud.

1. Carrier: Provide heavy-duty carrier.

B. Carrier: Provide heavy-duty carrier. Install at handicapped height.

2.06 LAVATORIES

A. LAV 1 countertop with integral bowl.

1. Faucet: Chicago Faucet Model 2302-ABCP. Chrome, deck mounted single hole with side valve single lever, with vandal-resistant 2.2 GPM aerator, chrome water supply piping with lockshield angle stops, and vandal-resistant, time-adjustable, 2 in. minimum diameter, palm pushbuttons indexed “H” and “C.” Faucet shall have full flow during all times of operation.

2. Drain: Chicago Faucet Chrome grid, 1 1/4 in. chrome 17 ga. tailpiece, chrome cast brass trap with cleanout plug, and chrome 17 ga. drain to wall. coordinate with sink bowl.

3. Escutcheon plates: Chrome metal supply and waste.

2.07 WASH FOUNTAIN

A. WF 1: Bradley “Classic” Model WF2704 Type A. 54 in. diameter, semicircular, stainless steel basin, nylon liquid soap dispenser with vandal-resistant filler cap, vandal-resistant restraining bracket, stainless steel scuff bases, vandal-resistant panels and backsplash, foot-operated self-closing valve, flow control, 3.0 GPM water-saver sprayhead, spud and strainer, thermostatic mixing valve, and combination stop, strainer, and check valves on hot and cold. Install 1 1/2 in. cast brass trap with cleanout plug, 17 ga. drain to wall, water supply piping with wheel stops, and chrome metal supply and waste escutcheon plates. Secure to wall.

2.08 MOP SERVICE BASIN

A. MSB 1: Fiat Model MSB 2424. Molded stone, 24 in. x 24 in. x 10 in. high, 3 in. outlet.

1. Faucet: Chicago Faucet Model 897. Service sink faucet at 3.0 GPM, bucket hook, hose end rigid spout with top wall brace, vacuum breaker, lever handles, stops in shanks, rough chrome-plated. Mount faucet at 36 in. above finished floor.

2. Strainer: Fiat Model 1453 BB.

3. Hose and hose bracket: Fiat Model 832 AA.

4. Mop hanger: Fiat Model 889 CC. Install at 4 ft. 0 in. above finished floor on abutting wall from faucet and centered on basin.

5. Vinyl bumper guards: Fiat Model E 77 AA. Provide for all exposed edges.

6. Wall guards: Fiat Model MSG 2424. 18 ga. stainless steel with stainless steel screws on (2) abutting walls and Fiat #833AA silicone sealant

PART 3 EXECUTION

3.01 INSTALLATION OF COMMERCIAL PLUMBING FIXTURES

A. Lavatory Installation:

1. Install lavatories level and plumb in accordance with roughing-in drawings.
2. Install supports, affixed to building substrate, for wall-mounted lavatories.
3. Install accessible, wall-mounted lavatories at mounting height in accordance with ICC A117.1.

locations that are accessible for ease of operation.

5. Install trap and waste piping on each drain outlet of each lavatory to be connected to sanitary drainage system.
6. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."
7. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
8. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

B. Sink Installation:

1. Install sinks level and plumb in accordance with roughing-in drawings.
2. Install supports, affixed to building substrate, for wall-mounted sinks.
3. Install accessible, wall-mounted sinks at mounting height in accordance with ICC A117.1.
4. Set floor-mounted sinks in leveling bed of cement grout.
5. Install water-supply piping with stop on each supply to each sink faucet.

    a. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523 "General Duty Valves for Plumbing Piping."
    b. Install stops/valves in locations that are accessible for ease of operation.

6. Install trap and waste piping on each drain outlet of each sink to be connected to sanitary drainage system.
7. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."
8. Seal joints between sinks, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
9. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible

C. Urinal Installation:

1. Install urinals level and plumb in accordance with roughing-in drawings.
2. Install wall-hung, back-outlet urinals onto waste-fitting seals and attached to supports.
3. Install wall-hung, bottom-outlet urinals with tubular waste piping attached to supports.
4. Install accessible, wall-mounted urinals at mounting height in accordance with ICC A117.1.
5. Install trap-seal liquid in waterless urinals.
6. Install supports, affixed to building substrate, for wall-hung urinals.
7. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
8. Use carriers without waste fitting for urinals with tubular waste piping.
9. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.
10. Measure support height installation from finished floor, not structural floor.
11. Install flushometer-valve, water-supply fitting on each supply to each urinal.
12. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
13. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
14. Install actuators in locations easily reachable for people with disabilities.
15. Install new batteries in battery-powered, electronic-sensor mechanisms.

Install deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."

17. Seal joints between urinals, walls, and floors using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to urinal color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
18.

D. Water Closet Installation:

1. Install water closets level and plumb in accordance with roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height in accordance with ICC A117.1.
4. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
5. Use carrier supports with waste-fitting assembly and seal.
6. Install floor-mounted, back-outlet water closets, attached to building floor substrate, onto waste-fitting seals; and attach to support.
7. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals, and affix to building substrate.
8. Measure support height installation from finished floor, not structural floor.
9. Install flushometer-valve, water-supply fitting on each supply to each water closet.
10. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
11. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
12. Install actuators in locations easily reachable for people with disabilities.
13. Install new batteries in battery-powered, electronic-sensor mechanisms.
14. Install toilet seats on water closets.
15. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Install deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."
16. Seal joints between water closets, walls, and floors using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to water-closet color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
17.

3.02 INSTALLATION OF PIPING CONNECTIONS

A. Connect plumbing fixtures with water supplies and soil, waste, and vent piping. Use size fittings required to match plumbing fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil, waste, and vent piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Install protective-shielding pipe covers and enclosures on exposed supplies and waste piping of accessible plumbing fixtures. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

E. Where installing piping adjacent to water closets and urinals, allow space for service and maintenance.

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

3.04 INSTALLATION OF CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.05 CLEANING AND PROTECTION

A. After completing installation of plumbing fixtures, inspect and repair damages finishes. Replace any fixtures unable to be repaired to the satisfaction of the Owner.

B. Clean plumbing fixtures and associated faucets, valves, flushometer valves, and fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed plumbing fixtures and associated faucets, valves, flushometer valves, and fittings.

D. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 00

SECTION 22 45 00

EMERGENCY PLUMBING FIXTURES

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide emergency plumbing fixtures installed in place, complete with supports, supply, and waste trim as indicated on the Drawings.

B. All fixtures shall have vandal-resistant handles, aerators, escutcheons, nuts, and bolts.

C. All trim and exposed piping shall be chrome-plated, unless noted otherwise.

D. Exposed metal parts shall be nonferrous and chrome-plated, unless otherwise noted.

E. All emergency fixtures shall be of commercial quality and free of defects.

F. Provide trim, fittings, and all accessories required for a complete installation.

G. Fixture connection sizes are shown on Drawings.

1.02 ACTION SUBMITTALS

A. Product data.

B. Shop Drawings:

- Plans, elevations, sections, and **mounting** details.
- Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- Diagrams for power, signal, and control wiring.

1.03 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Emergency fixture third-party certification documentation.

1.04 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 PRODUCTS

2.01 PLUMBING FIXTURES AND ACCESSORIES

A. Acceptable Fixture Manufacturers for Emergency Shower and Eye Wash: Guardian, Bradley, Encon, Haws, Speakman, Water Saver, or Western.

B. Manufacturer and Model Number listed below under other paragraphs of Part 2 shall be considered to be the Design Base Manufacturer and Model Number. Other Acceptable Manufacturers listed herein will be permitted, unless specifically excluded.

2.02 EMERGENCY SHOWER/EYE WASH

A. ESEW 1: Guardian GBF1909-GC-FC20-TMV. Floor mounted, ADA-compliant emergency shower and eye wash. Green ABS plastic shower head with stay open ball valve with pull rod and triangular handle, four ABS plastic soft flow eye/face spray with stay open ball valve with push flag, stainless steel bowl and thermostatic mixing valve assembly (set outlet temperature for 85 degrees F). Provide 1 1/4 in. water supply and 1 1/2 in. drain. Provide dust cover assembly. Install “Emergency Shower/Eye Wash” identification sign on emergency shower vertical pipe. Unit shall conform to ANSI Z358.1-2004. Secure unit to floor and wall.

PART 3 EXECUTION

3.01 INSTALLATION OF EMERGENCY PLUMBING FIXTURES

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures, to facilitate maintenance of equipment. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."

1. Exceptions:

a. Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
b. Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.

E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."

F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

G. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

H. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

I. Fill self-contained fixtures with flushing fluid.

1.2 PIPING CONNECTIONS

A. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 221116 "Domestic Water Piping."

B. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste or storm drainage piping.

C. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

1.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

1.4 IDENTIFICATION

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 220553 "Identification for Plumbing Piping and Equipment."

1.5 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.

2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Emergency plumbing fixtures **and water-tempering equipment** will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

1.6 ADJUSTING

A. Operate and adjust emergency plumbing fixtures and controls. Replace damaged and malfunctioning fixtures and controls.

B. Adjust or replace fixture flow regulators for proper flow.

C. Adjust equipment temperature settings.

1.7 CLEANING AND PROTECTION

A. Clean emergency plumbing fixtures with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed emergency plumbing fixtures and fittings.

C. Do not allow use of emergency plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 45 00

SECTION 22 47 00

DRINKING FOUNTAINS AND WATER COOLERS

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide electric water coolers and drinking fountains installed in place, complete with supports, supply, and waste trim as indicated on the Drawings.

B. All fixtures shall have vandal-resistant handles, escutcheons, carriers, nuts, and bolts.

C. All trim and exposed piping shall be chrome-plated, unless noted otherwise.

D. All electric water coolers and drinking fountains shall be of commercial quality and free of defects.

E. Provide trim, fittings, carriers, angle stops, chrome water supply piping, and all accessories required for a complete installation.

F. Fixture connection sizes are shown on Drawings.

G. All electric water coolers and drinking fountains resting against a wall shall be caulked with silicone sealant of a color to match the fixture. Remove excess material after fixture installation.

1.02 ACTION SUBMITTALS

A. Product Data
B. Product Data submittals.
C. Shop Drawings

1.03 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written instructions for delivery, storage, and handling.

PART 2 PRODUCTS

2.01 PLUMBING FIXTURES AND ACCESSORIES

A. Acceptable Fixture Manufacturers: Electric water coolers: Oasis, Aquarius, Elkay, Haws, Sunroc, White-Westinghouse, Halsey-Taylor, or Western.

B. Acceptable Accessory Manufacturers for Supplies, Escutcheons, and Traps: Brasscraft, Bridgeport, Consolidated, Frost, Waterway, McGuire Mfg. Co., Dearborn, Sanitary-Dash, Speedway, Zurn, or Anso-Flex.

C. Manufacturer and Model Number listed below under other paragraphs of Part 2 shall be considered to be the Design Base Manufacturer and Model Number. Other Acceptable Manufacturers listed herein will be permitted, unless specifically excluded.

2.02 CARRIERS

A. All carriers shall be specifically chosen to accommodate the particular brand and style of fixture actually installed, the particular type of floor and wall actually present at each fixture location, and the piping arrangement at each fixture. Furnish plastic or metal positioning frames to isolate carrier bolts from wall construction.

B. Provide a heavy-duty, rectangular vertical support, floor-supported, commercial type fixture carrier for each wall-mounted plumbing fixture, unless noted otherwise.

C. Water Cooler: Zurn Model Z1225.

D. Other Acceptable Manufacturers: Approved equal by Jay R. Smith, Wade, or Josam.

2.03 ELECTRIC WATER COOLERS

A. EWC 1 (ADA-compliant, Wall-mounted): Oasis Model P8AC. “Flex-Guard” bubbler, lead-free waterways, push-and-release push pads, rated at 8 GPH of 50 deg. F. water at 80 deg. F. EWT, 90 deg. F. room temperature, 1/4 HP compressor, 120 volts, cord and plug, UL-listed/labeled, 1 1/2 in. tailpiece, 5 year compressor warranty, and stainless steel top. Cabinet shall be “Sandstone” powder coated paint on galvanized steel. Set outlet thermostat for 50 deg. F. Chrome cast brass trap with cleanout plug, 17 ga. drain to wall, chrome water supply piping with wheel angle stop, and chrome metal supply and waste escutcheon plates. PROVIDE CARRIER.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF EQUIPMENT

A. Install fixtures level and plumb in accordance with roughing-in drawings. For fixtures indicated for juveniles, install at height required by authorities having jurisdiction.

B. Set pedestal drinking fountains and bottle filling stations on flat surface in accordance with manufacturer's written installation instructions.

C. Set freestanding water coolers on floor.

D. Install recessed drinking fountains and bottle filling stations secured to wood blocking in wall construction.

E. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

F. Install mounting frames, affixed to building construction, and attach recessed water coolers and bottle filling stations to mounting frames.

G. Set remote water coolers on floor unless otherwise indicated.

H. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

I. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

J. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."

K. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.03 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Install ball shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 220523 "General-Duty Valves for Plumbing Piping."

D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.04 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection

a. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
b. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

3.05 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust electronic-sensor settings.

3.06 CLEANING

A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, in accordance with manufacturer's written instructions.

C. Provide protective covering for installed fixtures.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 47 00

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Motors.
2. Packed expansion joints.
3. Packless expansion joints.
4. Alignment guides and anchors.
5. Sleeves without waterstop.
6. Sleeves with waterstop.
7. Stack-sleeve fittings.
8. Sleeve-seal systems.
9. Grout.
10. Silicone sealants.
11. Escutcheons.
12. Thermometers, bimetallic actuated.
13. Thermometers, liquid in glass.
14. Thermometers, light activated.
15. Duct-thermometer mounting brackets.
16. Thermowells.
17. Pressure gauges, dial type.
18. Gauge attachments.
19. Flowmeters.
20. Thermal-energy meters.

B. Related Requirements:

1. Section 221124 "Facility Natural-Gas Piping" for gas meters.

1.2 ACTION SUBMITTALS

A. Product data.

B. Delegated Design Submittals: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.
1. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
2. Alignment Guide Details: Detail field assembly and attachment to building structure.
3. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter.

B. Welding certificates.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

1.6 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 MOTORS

A. Motor Requirements, General:

1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.
3. Comply with NEMA MG 1 unless otherwise indicated.

B. Motor Characteristics:

1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 ft. (1000 m) above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Polyphase Motors:

1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium Efficient, as defined in NEMA MG 1.
3. Service Factor: 1.15.
4. Multispeed Motors: Variable torque.

    a. For motors with 2:1 speed ratio, consequent pole, single winding.
    b. For motors with other than 2:1 speed ratio, separate winding for each speed.

5. Rotor: Random-wound, squirrel cage.
6. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
7. Temperature Rise: Match insulation rating.
8. Insulation: **Class F**.
9. Code Letter Designation:

    a. Motors 15 Hp and Larger: NEMA starting Code F or Code G.
    b. Motors Smaller Than 15 Hp: Manufacturer's standard starting characteristic.

10. Enclosure Material: Cast iron for motor frame sizes **324T** and larger; rolled steel for motor frame sizes smaller than **324T**.

D. Additional Requirements for Polyphase Motors:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
2. Motors Used with Variable-Frequency Controllers: **Ratings, characteristics, and features coordinated with and approved by controller manufacturer.**

    a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time-rise pulses produced by pulse-width-modulated inverters.
    b. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
    c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
    d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

E. Single-Phase Motors:

1. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:

    a. Permanent-split capacitor.
    b. Split phase.
    c. Capacitor start, inductor run.
    d. Capacitor start, capacitor run.

2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 hp and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

F. Electronically Commutated Motors:

1. Microprocessor-Based Electronic Control Module: Converts **120 V or 240 V** single-phase AC power to three-phase DC power to operate the brushless DC motor.
2. Three-phase power motor module with permanent magnet rotor.
3. **digital speed controller/LED display**.
4. Building Automation System Interface: Via **AC voltage signal**, **DC voltage signal**, **or Digital Serial Interface (DSI)**.

2.2 EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

A. Performance Requirements:

1. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.
2. Capability: Provide products and installations that will accommodate maximum axial movement as scheduled or indicated on Drawings.

B. Packed Expansion Joints:

1. Flexible, Ball-Joint Packed Expansion Joints: **FBJ-01**.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Advanced Thermal Systems, Inc.
2) Hyspan Precision Products, Inc.
3) Mason Industries, Inc.

b. Source Limitations: Obtain rubber union connector expansion joints from single manufacturer.
c. Standards: 2021 ASME Boiler and Pressure Vessel Code: Section II, "Materials"; ASME B31.9 for materials and design of pressure-containing parts and bolting.
d. Material: Carbon-steel assembly with asbestos-free composition packing.
e. Design: Provide 360-degree rotation and angular deflection.
f. Minimum Pressure Rating: **250 psig at 400 deg F (1725 kPa at 204 deg C)**.
g. Angular Deflection for NPS 6 (DN 150) and Smaller: 30 degrees minimum.
h. Angular Deflection for NPS 8 (DN 200) and Larger: 15 degrees minimum.
i. Seal Type: Two carbon-steel and graphite seals suitable for continuous operation at temperature up to 650 deg F (343 deg C).
j. Internal Ball: Plated with minimum 1-mil chrome cover.
k. Ball Socket: One- or two-piece design with integral socket/retainer.

1) Stuffing Box: Incorporates containment seals and compression seals for containment of injectable packing.
2) Packing Cylinders: Provides packing under full line pressure with check valves to prevent blowback.

l. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
m. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

2. Slip-Joint Packed Expansion Joints: **SJ-01**.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Adsco Manufacturing LLC.
2) Advanced Thermal Systems, Inc.
3) Hyspan Precision Products, Inc.
4) Metraflex Company (The).

b. Source Limitations: Obtain slip-joint packed expansion joints from single manufacturer.
c. Standard: ASTM F1007.
d. Material: Carbon steel with asbestos-free PTFE packing.
e. Design: With internal guide and injection ports for repacking under full system pressure. Housing is to be furnished with drain ports and lifting ring. Include drip connection if used for steam piping.
f. Configuration: **Single joint**, **single joint with base**, **and**, **double joint with base** class(es) unless otherwise indicated.
g. Slip Tube for Sizes NPS 1-1/2 (DN 40) through NPS 16 (DN 400): Schedule 80.
h. Slip Tube for Sizes NPS 18 (DN 450) through NPS 24 (DN 600): Schedule 60.
i. Sliding Surface: 2-mil-thick chrome finish.
j. End Connections: Flanged or welded ends to match piping system.

C. Packless Expansion Joints:

1. Metal, Compensator Packless Expansion Joints: **MCEJ-01**.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Flex-Hose Co., Inc.
2) Flex-Weld Inc., div of Kelco Industries.
3) Flex-Weld; a division of Kelco.
4) Flexicraft Industries.
5) Hyspan Precision Products, Inc.
6) Metraflex Company (The).

b. Source Limitations: Obtain metal compensator packless expansion joints from single manufacturer.
c. Minimum Pressure Rating: **150 psig (1035 kPa)** unless otherwise indicated.
d. Description: Totally enclosed, externally pressurized, multi-ply bellows isolated from fluid flow by an internal pipe sleeve and external housing.

e. Joint Axial Movement: 2 inches (50 mm) of compression and 1/2 inch (12 mm) of extension.
f. Configuration for Copper Tubing: Multi-ply, phosphor-bronze bellows with copper pipe ends.

1) End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: **Solder joint or threaded**.
2) End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Threaded.

g. Configuration for Steel Piping: Multi-ply, stainless steel bellows; steel-pipe end connections; and carbon-steel shroud.

1) End Connections for Steel Pipe NPS 2 (DN 50) and Smaller: Threaded.
2) End Connections for Steel Pipe NPS 2-1/2 to NPS 4 (DN 65 to DN 100): **Welded**.

2. Rubber Union Connector Expansion Joints: **RUEJ-01**.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Amber/Booth Company, Inc.; a VMC Group Company.
2) Flex-Hose Co., Inc.
3) Flo Fab Inc.
4) General Rubber Corporation.
5) Kadant Unaflex, LLC.
6) Metraflex Company (The).
7) Proco Products, Inc.
8) Unisource Manufacturing, Inc.

b. Source Limitations: Obtain rubber union connector expansion joints from single manufacturer.
c. Material: Twin reinforced-rubber spheres.
d. Minimum Pressure Rating: **150 psig at 170 deg F (1035 kPa at 77 deg C)**unless otherwise indicated.
e. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
f. End Connections for Greater than NPS 2 (DN 50): Flanged.

3. Flexible-Hose Packless Expansion Joints: **FHEJ-01**.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) ASC Engineered Solutions.
2) Flex-Hose Co., Inc.
3) Flex-Pression.
4) Flex-Weld Inc., div of Kelco Industries.
5) Flex-Weld; a division of Kelco.
6) Flexicraft Industries.
7) Kadant Unaflex, LLC.

8) Metraflex Company (The).
9) Proco Products, Inc.
10) Unisource Manufacturing, Inc.

b. Source Limitations: Obtain flexible-hose packless expansion joints from single manufacturer.
c. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
d. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
e. Expansion Joints for Copper Tubing NPS 2 (DN 50) and Smaller: Copper-alloy fittings with **solder-joint** end connections.

1) Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 340 psig at 450 deg F (2340 kPa at 232 deg C) ratings.
2) Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F (4830 kPa at 21 deg C) and 500 psig at 450 deg F (3450 kPa at 232 deg C) ratings.

f. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Copper-alloy fittings with **threaded** end connections.

1) Stainless steel hoses and single-braid, stainless steel sheaths with 300 psig at 70 deg F (2070 kPa at 21 deg C) and 225 psig at 450 deg F (1550 kPa at 232 deg C) ratings.
2) Stainless steel hoses and double-braid, stainless steel sheaths with 420 psig at 70 deg F (2890 kPa at 21 deg C) and 315 psig at 450 deg F (2170 kPa at 232 deg C) ratings.

g. Expansion Joints for Steel Piping NPS 2 (DN 50) and Smaller: Carbon-steel fittings with threaded end connections.

1) Stainless steel hoses and single-braid, stainless steel sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 325 psig at 600 deg F (2250 kPa at 315 deg C) ratings.
2) Stainless steel hoses and double-braid, stainless steel sheaths with 700 psig at 70 deg F (4830 kPa at 21 deg C) and 515 psig at 600 deg F (3550 kPa at 315 deg C) ratings.

h. Permanent Locking Bolts: Set locking bolts to maintain joint lengths during installation. Temporary welding tabs that are removed after installation in lieu of locking bolts are unacceptable.
i. End Connection Configuration: Flanged; one raised, fixed and one floating flange.

D. Alignment Guides and Anchors:

1. Alignment Guides: **AG-01**.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) ASC Engineered Solutions.
2) Advanced Thermal Systems, Inc.
3) Amber/Booth Company, Inc.; a VMC Group Company.
4) Flex-Hose Co., Inc.
5) Flex-Pression.
6) Flex-Weld Inc., div of Kelco Industries.
7) Flex-Weld; a division of Kelco.
8) Flexicraft Industries.
9) Hyspan Precision Products, Inc.
10) Metraflex Company (The).

b. Source Limitations: Obtain alignment guides from single manufacturer.
c. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe. Provide dielectric spacer for use with copper tubing/piping.

2. Anchor Materials:

a. Steel Shapes and Plates: ASTM A36/A36M.
b. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
c. Washers: ASTM F844, steel, plain, flat washers.
d. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

1) Stud: Threaded, **zinc-coated carbon** or **stainless** steel.
2) Expansion Plug: **Zinc-coated carbon** or **Stainless** steel.
3) Washer and Nut: **Zinc-coated carbon** or **Stainless** steel.

e. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

1) Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
2) Stud: ASTM A307, **zinc-coated carbon** or **stainless** steel with continuous thread on stud, unless otherwise indicated.
3) Washer and Nut: **Zinc-coated carbon** or **Stainless** steel.

2.3 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
3. Steel Sheet Sleeves: ASTM A653/A653M, 24 gauge (0.6 mm) minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.

B. Sleeves with Waterstop:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Advance Products & Systems, LLC.
   b. CALPICO, Inc.
   c. GPT; a division of EnPRO Industries.
   d. Metraflex Company (The).

2. Description: Manufactured **galvanized-steel**, sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.

C. Sleeve-Seal Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Advance Products & Systems, LLC.
   b. Airex Manufacturing Inc.
   c. CALPICO, Inc.
   d. GPT; a division of EnPRO Industries.
   e. Metraflex Company (The).
   f. Proco Products, Inc.

2. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

   a. Hydrostatic Seal: 20 psig (137 kPa) minimum).
   b. Sealing Elements: **High-temperature-silicone** interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
   c. Pressure Plates: **Carbon steel**.
   d. Connecting Bolts and Nuts: **Carbon steel, with zinc coating. ASTM B633** of length required to secure pressure plates to sealing elements.

D. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: 5000 psi (34.5 MPa), 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

E. Silicone Sealants:

1. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) GE Construction Sealants; Momentive Performance Materials Inc.
2) ITW Polymers Sealants North America.
3) Polymeric Systems, Inc.; PPG Industries, Inc.
4) Sherwin-Williams Company (The).
5) Sika Corporation.
6) The Dow Chemical Company.
7) Tremco Incorporated.

b. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.

2.4 ESCUTCHEONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. BrassCraft Manufacturing Co.; a Masco company.
2. Dearborn Brass.
3. Jones Stephens Corp.
4. Keeney Manufacturing Company (The).
5. Mid-America Fittings, LLC; A Midland Industries Company.
6. ProFlo; a Ferguson Enterprises, Inc. brand.

B. Escutcheon Types:

1. One-Piece, Steel Type: With **polished, chrome-plated** finish and setscrew fastener.
2. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped **steel** with polished, chrome-plated finish and spring-clip fasteners.
3. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
4. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; **concealed and exposed-rivet** hinge; and spring-clip fasteners.

C. Floor Plates:

1. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION OF PACKED EXPANSION JOINTS

A. Install packed expansion joints with packing suitable for fluid service.

3.2 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install **one** guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than **four** pipe diameters from expansion joint.

C. Attach guides to pipe, and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9.
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-58, Type 24; U bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

3.3 INSTALLATION OF PIPE LOOPS AND SWING CONNECTIONS

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least f**ive** pipe fittings, including tee in main.

C. Connect risers and branch connections to terminal units with at least **four** pipe fittings, including tee in riser.

D. Connect mains and branch connections to terminal units with at least **four** pipe fittings, including tee in main.

3.4 INSTALLATION OF SLEEVES - GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide **1-inch (25-mm)** annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas **2 inches (50 mm)** above finished floor level.

2. Using **grout or silicone sealant**, seal space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width of concrete slab or wall.

C. Secure nailing flanges to wooden concrete forms.

D. Using **grout or silicone sealant**, seal space around outside of sleeves.

3.6 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.7 INSTALLATION OF ESCUTCHEONS

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

3.8 INSTALLATION OF METERS AND GAUGES

A. Install thermowells with socket extending **one-third of pipe diameter** and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing, and support tubing to prevent kinks. Use minimum tubing length.

G. Install pipe-mounted thermal-energy temperature sensors in thermowells and extend wiring to indicator.

H. Install duct-thermometer-mounting brackets in walls of ducts. Attach to duct with screws.

I. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.

J. Install remote-mounted pressure gauges on panel.

K. Install valve and snubber in piping for each pressure gauge for fluids (except steam).

L. Install valve and syphon fitting in piping for each pressure gauge for steam.

M. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

N. Install flowmeter elements in accessible positions in piping systems.

O. Install all flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.

P. Install permanent indicators on walls or brackets in accessible and readable positions.

Q. Install connection fittings in accessible locations for attachment to portable indicators.

R. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.

S. Install thermometers in the following locations:
   1. Outside-, return-, supply-, and mixed-air ducts.

T. Install pressure gauges in the following locations:

   1. Discharge of each pressure-reducing valve.

3.9 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

D. Connect thermal-energy meter transmitters to meters.

3.10 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gauges to proper angle for best visibility.

3.11 FIELD QUALITY CONTROL

A. Sleeves and Sleeve Seals:

1. Perform the following tests and inspections:

a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

2. Prepare test and inspection reports.

B. Escutcheons:

1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.12 SLEEVES APPLICATION

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for **1-inch (25-mm)** annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for **1-inch (25-mm)** annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

a. **Sleeves with waterstops or stack-sleeve fittings**.

4. Interior Walls and Partitions:

a. Sleeves without waterstops.

3.13 ESCUTCHEONS APPLICATION

A. Escutcheons for New Piping and Relocated Existing Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Chrome-Plated Piping: One piece, **steel** with polished, chrome-plated finish.
3. Insulated Piping:

a. One piece, steel with **polished, chrome-plated** finish.
b. One piece, stamped steel with polished, chrome-plated finish.

4. Bare Piping at Wall and Floor Penetrations in Finished Spaces:

a. One piece, steel with **polished, chrome-plated** finish.
b. One piece, cast brass with **polished, chrome-plated** finish.
c. One piece, stamped steel with polished, chrome-plated finish.

5. Bare Piping at Ceiling Penetrations in Finished Spaces:

a. One piece, steel with **polished, chrome-plate** finish.
b. One piece, cast brass with **polished, chrome-plated** finish.
c. One piece, stamped steel with polished, chrome-plated finish.

B. Install floor plates for piping penetrations of equipment-room floors.

C. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping and Relocated Existing Piping: Split floor plate.
2. Existing Piping to Remain: Split floor plate.

3.14 PRESSURE-GAUGE APPLICATION

A. Pressure gauges on refrigerant piping.

END OF SECTION 230500

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports - metal.
2. Pipe hangers - metal, trapeze type.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Equipment supports.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 230500 "Common Work Results for HVAC" for pipe guides and anchors.
3. **Section 230548.13 "Vibration Controls for HVAC"** for vibration isolation devices.
4. **Section 233113 "Metal Ducts"** for duct hangers and supports.

1.2 ACTION SUBMITTALS

A. Product data.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Pipe stands.
3. Equipment supports.

C. Delegated Design Submittals: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication/assembly and design calculations for trapeze hangers.
2. Detail fabrication/assembly and design calculations for each type of strut support system, by the manufacturer's technical representative.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for HVAC piping and equipment are to withstand the effects of gravity loads and stresses within limits and under conditions indicated in accordance with **ASCE/SEI 7**.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 PIPE HANGERS AND SUPPORTS - METAL

A. Pipe Hangers and Supports - Carbon Steel:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil; an ASC Engineered Solution.
   b. B. Line Systems, Inc.
   c. Carpenter & Patterson, Inc.
   d. Erico/Michigan Hanger Co. Inc.
   e. Globe Pipe Hanger Products, Inc.
   f. Klo Shure
   g. National Pipe Hanger Corp.
   h. PHD Manufacturing, inc

2. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
3. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
4. Nonmetallic Coatings: Plastic coated, or epoxy powder coated.
5. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
6. Hanger Rods: Continuous-thread rod, nuts, and washers made of **carbon steel** .
   a. Provide 3/8 inch rod diameter for pipe sizes up to 2 inches.
   b. Provide double nut attachment to the hangar and at the hangar attachment.

B. Pipe Hangers and Supports - Stainless Steel:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil; an ASC Engineered Solution.
   b. B. Line Systems, Inc.
   c. Carpenter & Patterson, Inc.
   d. Erico/Michigan Hanger Co. Inc.
   e. Globe Pipe Hanger Products, Inc.
   f. Klo Shure
   g. National Pipe Hanger Corp.
   h. PHD Manufacturing, inc

2. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
3. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of **stainless steel**.
   a. Provide 3/8 inch rod diameter for pipe sizes up to 2 inches.
   b. Provide double nut attachment to the hangar and at the hangar attachment.

2.3 PIPE HANGERS - METAL, TRAPEZE TYPE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil; an ASC Engineered Solution.
   b. B. Line Systems, Inc.
   c. Carpenter & Patterson, Inc.
   d. Erico/Michigan Hanger Co. Inc.
   e. Globe Pipe Hanger Products, Inc.
   f. Klo Shure
   g. National Pipe Hanger Corp.
   h. PHD Manufacturing, inc

B. Description: Unistrut P1000 or Superstrut A1200. Angle iron, or channel of sufficient length to support pipes and insulation on individual hangers, roller supports or saddles with insulation protectors, support capacity, support spacing, trapeze hanger rod diameter, and quantity as required to support total piping load.

C. Provide individual piping attachments to each Unistrut hanger, angle, or channel.

D. Design support system and obtain approval of a Structural Engineer licensed in Ohio. Submit details to the A/E for approval.

E. Channel Support Systems Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. B. Line Systems, Inc.
   b. Erico/Michigan Hanger Co. Inc.

c. GS Metals Corp.
d. National Pipe Hanger Corp.
e. Powerstruct
f. Unistrut Corp.
g. Wesanco, Inc.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Buckaroos, Inc.
2. Carpenter & Paterson, Inc.
3. PHS Industries
4. Pipe Shields Inc.
5. Rilco Manufacturing Co., Inc.
6. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: **ASTM C552, Type II cellular glass with 100 psi (688 kPa) or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125 psi (862 kPa)** minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: **Water-repellent-treated, ASTM C533, Type I calcium silicate with 100 psi (688 kPa)** or **ASTM C552, Type II cellular glass with 100 psi (688 kPa) or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125 psi (862 kPa)** minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield are to cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield are to cover bottom 180 degrees of pipe.

F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Fastener System - Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities required for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hilti, Inc.
b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
c. MKT Fastening, LLC.

B. Fastener System - Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities required for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Cooper B-line; brand of Eaton, Electrical Sector.
    b. Empire Industries, Inc.
    c. Hilti, Inc.
    d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
    e. MKT Fastening, LLC.

2. Indoor Applications: **Zinc-plated or stainless**] steel.
3. Outdoor Applications: Stainless steel.

2.6 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.7 MATERIALS

A. Aluminum: ASTM B221 (ASTM B221M).

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

F. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000 psi (34.5 MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry static loads within specified loading limits. Minimum static design load used for strength determination is to include weight of supported components plus **200 lb (90 kg)**.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

B. Install lateral bracing with pipe hangers and supports to prevent swaying.

C. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, **NPS 2-1/2 (DN 65)** and larger **and at changes in direction of piping**. Coordinate location of concrete inserts before concrete is placed.

D. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

E. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

F. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Thermal-hanger shield inserts may be used as an option. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields are to span an arc of 180 degrees.

   a. Thermal-hanger shield inserts may be used as an option. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
      1) Anvil Fig 167. Half round piping shield inside clevis hangar.
   b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
   c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.

d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

G. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

H. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate in accordance with ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel in accordance with AWS D1.1/D1.1M.

I. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

J. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick after concrete is placed and cured. Use installers that are licensed by powder-actuated tool manufacturer.
2. Install mechanical-expansion anchors after concrete is placed and completely cured.
3. Install fasteners in accordance with manufacturer's written instructions.

K. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

L. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

M. Equipment Support Installation:

1. Fabricate from welded-structural-steel shapes.
2. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
3. Grouting: Place grout under supports for floor-mounted equipment, and make bearing surface smooth.
4. Provide lateral bracing, to prevent swaying.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for **trapeze pipe hangers and equipment supports**.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to [**1-1/2 inches (40 mm)**.

3.5 PAINTING

A. Touchup:

1. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

   a. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

2. Comply with requirements in **Section 099113 "Exterior Painting"** and **Section 099123 "Interior Painting"** for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
3. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel **pipe hangers and supports and metal trapeze pipe hangers** and attachments for general service applications.

F. Use **stainless steel pipe hangers** and **stainless steel or corrosion-resistant** attachments for corrosive environment applications.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Unless otherwise noted, all steel hangars and supports shall be standards black.
   1. Exception: Hangars and supports for exposed exterior applications shall be galvanized.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes; All Sizes.
      a. Insulated: Anvil Fig. 260.
      b. Non-Insulated: Anvil Fig. 69

   2. Carbon-Steel Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
   6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
   8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
   9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
   10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).

11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is unnecessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
22. For insulated refrigerant piping use insulated couplings by Klo Shure.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.
3. Friction Riser Clamp with 2-point bearing: Use Anvil Fig. CT 121 copper-plated riser clamp for copper pipe. Shorten legs as required to conceal riser clamp within pipe chase and still provide adequate support.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Beam Clamp and Wall Bracket Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil; an ASC Engineered Solution.
   b. B. Line Systems, Inc.
   c. Carpenter & Patterson, Inc.
   d. Erico/Michigan Hanger Co. Inc.
   e. Globe Pipe Hanger Products, Inc.
   f. Klo Shure
   g. National Pipe Hanger Corp.
   h. PHD Manufacturing, inc

2. Beam Clamps (up to 8 inch diameter pipe):
   a. Anvil Fig. 227.
      1) Top beam clamp, steel jaw, hook rod with nut, and spring washer steel eye-bolt, with Anvil Fig. 157 for appropriate rod diameter.

   b. Option: Anvil Fig. 86.
      1) Malleable iron clamp, hardened steel cup point set screw with Fig. 89 steel retaining clip.
      2) C CLAMPS WITHOUT RETAINING CLIPS ARE EXPRESSELY PROHIBITED.

3. Purlin Clamps:
   a. PHD Fig. 290 Purlin Clamp.
      1) Malleable iron with jam nut, and pointed steel set screw.

4. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

5. In Pre-cast Concrete: Anvil Fig. 117. Malleable iron, expansion case, interior standard pipe threads, external helical wedge. Hilti or Philips.

6. For Pre-Cast Flexicore Concrete: Provide concrete inserts, toggle bolts, etc., as required for HVAC Workd.
7. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
8. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
9. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
10. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
11. C-Clamps (MSS Type 23): For structural shapes.

12. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
13. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
14. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
15. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
16. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
17. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).

18. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
19. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
20. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

21. Wall Brackets: Carbon steel, black plates, and bolts.

    a. Anvil Fig. 194. Lightweight 750 lb. load.
    b. Anvil Fig. 195. Medium-weight 1,500 lb. load.
    c. Option: Unistrut Superstrut A1200.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Use **powder-actuated fasteners or mechanical-expansion anchors**] instead of building attachments where required in concrete construction.

3.7 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A36 / ASTM A36 M, steel plates, shapes, and bars, black and galvanized.

END OF SECTION 230529

SECTION 230548.13 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient support.
9. Resilient pipe guides.
10. Elastomeric hangers.
11. Spring hangers.
12. Snubbers.
13. Restraints - rigid type.
14. Restraints - cable type.
15. Restraint accessories.
16. Post-installed concrete anchors.
17. Concrete inserts.

B. Related Requirements:

1. Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.
2. Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment" for devices for plumbing equipment and systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints.

B. Welding certificates.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7 and be acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design system.

B. Consequential Damage: Provide additional restraints for suspended HVAC components or anchorage of floor-, roof-, or wall-mounted HVAC components as indicated in **ASCE/SEI 7-05**, **ASCE/SEI 7-10**, and **ASCE/SEI 7-16** so that failure of a non-essential or essential HVAC component will not cause the failure of any other essential architectural, mechanical, or electrical building component.

C. Fire/Smoke Resistance: All components that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

D. Component Supports:

1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ace Mountings Co., Inc.
b. CADDY; brand of nVent Electrical plc.
c. California Dynamics Corporation.
d. Isolation Technology, Inc.
e. Kinetics Noise Control, Inc.
f. Korfund.
g. Mason Industries, Inc.
h. NOVIA; a division of Carpenter & Paterson.
i. VMC GROUP.
j. Vibration Eliminator Co., Inc.
k. Vibration Isolation.
l. Vibration Management Corp.

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Minimum deflection as indicated on Drawings.
5. Pad Material: Oil- and water-resistant rubber.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: **Resilient and elastomeric**.
   a. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Elastomeric Isolation Mounts: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ace Mountings Co., Inc.
   b. CADDY; brand of nVent Electrical plc.
   c. California Dynamics Corporation.
   d. Isolation Technology, Inc.
   e. Kinetics Noise Control, Inc.
   f. Korfund.
   g. Mason Industries, Inc.
   h. NOVIA; a division of Carpenter & Paterson.
   i. VMC GROUP.
   j. Vibration Eliminator Co., Inc.
   k. Vibration Isolation.
   l. Vibration Management Corp.

2. Mounting Plates:

   a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded **with threaded studs or bolts**.
   b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

3. Minimum deflection as indicated on Drawings.
4. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ace Mountings Co., Inc.
   b. CADDY; brand of nVent Electrical plc.
   c. California Dynamics Corporation.
   d. Isolation Technology, Inc.
   e. Kinetics Noise Control, Inc.
   f. Korfund.
   g. Mason Industries, Inc.
   h. NOVIA; a division of Carpenter & Paterson.
   i. VMC GROUP.
   j. Vibration Eliminator Co., Inc.
   k. Vibration Isolation.
   l. Vibration Management Corp.

2. Description: All-directional isolator with restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

   a. Housing: Cast-ductile iron or welded steel.
   b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

3. Minimum deflection as indicated on Drawings.

2.5 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ace Mountings Co., Inc.
   b. CADDY; brand of nVent Electrical plc.
   c. California Dynamics Corporation.
   d. Isolation Technology, Inc.
   e. Kinetics Noise Control, Inc.
   f. Korfund.
   g. Mason Industries, Inc.
   h. NOVIA; a division of Carpenter & Paterson.

i. VMC GROUP.
j. Vibration Eliminator Co., Inc.
k. Vibration Isolation.
l. Vibration Management Corp.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psi (3447 kPa).
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
8. Minimum deflection as indicated on Drawings.

2.6 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ace Mountings Co., Inc.
b. CADDY; brand of nVent Electrical plc.
c. California Dynamics Corporation.
d. Isolation Technology, Inc.
e. Kinetics Noise Control, Inc.
f. Korfund.
g. Mason Industries, Inc.
h. VMC GROUP.
i. Vibration Eliminator Co., Inc.
j. Vibration Isolation.
k. Vibration Management Corp.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Minimum deflection as indicated on Drawings.
7. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psi (3447 kPa).
b. Top housing with **attachment and leveling bolt** .

2.7 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ace Mountings Co., Inc.
   b. CADDY; brand of nVent Electrical plc.
   c. California Dynamics Corporation.
   d. Isolation Technology, Inc.
   e. Kinetics Noise Control, Inc.
   f. Korfund.
   g. Mason Industries, Inc.
   h. NOVIA; a division of Carpenter & Paterson.
   i. VMC GROUP.
   j. Vibration Eliminator Co., Inc.
   k. Vibration Isolation.
   l. Vibration Management Corp.

2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

   a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psi (3447 kPa).
   b. Top plate with **threaded mounting holes**.
   c. Internal leveling bolt that acts as blocking during installation.

3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Minimum deflection as indicated on Drawings.

2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ace Mountings Co., Inc.
   b. CADDY; brand of nVent Electrical plc.
   c. California Dynamics Corporation.
   d. Isolation Technology, Inc.
   e. Kinetics Noise Control, Inc.

f. Korfund.
g. Mason Industries, Inc.
h. VMC GROUP.
i. Vibration Eliminator Co., Inc.
j. Vibration Isolation.
k. Vibration Management Corp.

2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with **adjustable** snubbers to limit vertical movement.

   a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psi (3447 kPa).
   b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Minimum deflection as indicated on Drawings.

2.9 PIPE-RISER RESILIENT SUPPORT

A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-inch- (13-mm-) Thick Neoprene:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. California Dynamics Corporation.
   b. Kinetics Noise Control, Inc.
   c. Mason Industries, Inc.
   d. Vibration Eliminator Co., Inc.
   e. Vibration Management Corp.

2. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
3. Maximum Load Per Support: 500 psi (3447 kPa) on isolation material providing equal isolation in all directions.
4. Minimum deflection as indicated on Drawings.

2.10 RESILIENT PIPE GUIDES

A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-inch- (13-mm-) Thick Neoprene:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. California Dynamics Corporation.
    b. Kinetics Noise Control, Inc.
    c. Mason Industries, Inc.
    d. VMC GROUP.
    e. Vibration Eliminator Co., Inc.
    f. Vibration Management Corp.

2. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.11 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Ace Mountings Co., Inc.
    b. CADDY; brand of nVent Electrical plc.
    c. California Dynamics Corporation.
    d. Kinetics Noise Control, Inc.
    e. Mason Industries, Inc.
    f. NOVIA; a division of Carpenter & Paterson.
    g. VMC GROUP.
    h. Vibration Eliminator Co., Inc.
    i. Vibration Isolation.
    j. Vibration Management Corp.

2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.
4. Minimum deflection as indicated on Drawings.

2.12 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Ace Mountings Co., Inc.
    b. CADDY; brand of nVent Electrical plc.
    c. California Dynamics Corporation.
    d. Kinetics Noise Control, Inc.

e. Mason Industries, Inc.
f. NOVIA; a division of Carpenter & Paterson.
g. VMC GROUP.
h. Vibration Eliminator Co., Inc.
i. Vibration Isolation.
j. Vibration Management Corp.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Minimum deflection as indicated on Drawings.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
9. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
10. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.13 SNUBBERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CADDY; brand of nVent Electrical plc.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.
4. VMC GROUP.
5. Vibration Management Corp.

B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be prequalified in accordance with ACI 355.2 testing and designated in accordance with **ACI 318-14 Ch. 17 for 2015 or 2018 IBC**

2. Preset Concrete Inserts: Prequalified in accordance with ICC-ES AC446 testing.
3. Anchors in Masonry: Design in accordance with TMS 402.
4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
5. Resilient Cushion: Maximum 1/4-inch (6-mm) air gap, and minimum 1/4 inch (6 mm) thick.

2.14 RESTRAINTS - RIGID TYPE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Atkore Unistrut.
2. CADDY; brand of nVent Electrical plc.
3. California Dynamics Corporation.
4. Cooper B-line; brand of Eaton, Electrical Sector.
5. Hilti, Inc.
6. Isolation Technology, Inc.
7. TOLCO Incorporated.
8. VMC GROUP.

B. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.15 RESTRAINTS - CABLE TYPE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CADDY; brand of nVent Electrical plc.
2. Cooper B-line; brand of Eaton, Electrical Sector.
3. Gripple Inc.
4. Loos & Co. Inc.
5. VMC GROUP.

B. Restraint Cables: **ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel** cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.

C. Restraint cable assembly and cable fittings must comply with **ASCE/SEI 19-10** and **ASCE/SEI 19-1**. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.16 RESTRAINT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Atkore Unistrut.
2. CADDY; brand of nVent Electrical plc.
3. Cooper B-line; brand of Eaton, Electrical Sector.

4. Hilti, Inc.
5. Loos & Co. Inc.
6. Mason Industries, Inc.
7. TOLCO Incorporated.

B. Hanger-Rod Stiffener: **Steel tube or steel slotted-support-system sleeve with internally bolted connections** or **Reinforcing steel angle clamped** to hanger rod.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to **rigid channel bracings and restraint cables**.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.17 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Atkore Unistrut.
   b. Cooper B-line; brand of Eaton, Electrical Sector.
   c. Hilti, Inc.
   d. Mason Industries, Inc.
   e. Powers Fasteners.

2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Provide post-installed concrete anchors that have been prequalified for use in wind-load applications. Post-installed concrete anchors must comply with all requirements of **ASCE/SEI 7-05, Ch. 13**, **ASCE/SEI 7-10, Ch. 13**, and **ASCE/SEI 7-16, Ch. 13**.

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

C. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp (7.46 kW) that is not vibration isolated.

1. Undercut expansion anchors are permitted.

2.18 CONCRETE INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Atkore Unistrut.
2. Cooper B-line; brand of Eaton, Electrical Sector.
3. Hilti, Inc.
4. Mason Industries, Inc.
5. Powers Fasteners.

B. Provide preset concrete inserts that are prequalified in accordance with ICC-ES AC466 testing.

C. Comply with ANSI/MSS SP-58.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by **an evaluation service member of ICC-ES**.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to wind-load forces.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength is adequate to carry static and wind force loads within specified loading limits.

3.2 INSTALLATION OF VIBRATION CONTROL DEVICES

A. Provide vibration control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Device Schedules on Drawings, where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

C. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

D. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

E. Equipment Restraints:

1. Install snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
3. Install wind-load-restraint devices using methods approved by **an evaluation service member of ICC-ES** that provides required submittals for component.

F. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of **40 feet (12 m)** o.c., and longitudinal supports a maximum of **80 feet (24 m)** o.c.
3. Brace a change of direction longer than 12 feet (3.7 m).

G. Install wind-load-restraint cables so they do not bend across edges of adjacent equipment or building structure.

H. Install wind-load-restraint devices using methods approved by **an evaluation service member of ICC-ES** that provides required submittals for component.

I. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

J. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

K. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

L. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL MOTION

A. Provide flexible connections in piping systems where they cross structural joints and other point where differential movement may occur. Provide adequate flexibility to accommodate

differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties" for piping flexible connections.

3.4 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: **Engage** a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least **four** of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

END OF SECTION 230548.13

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Brady Corporation.
   b. Carlton Industries, LP.
   c. Champion America.
   d. Craftmark Pipe Markers.
   e. Kolbi Pipe Marker Co.
   f. LEM Products Inc.
   g. Marking Services Inc.
   h. Pipemarker.com; Brimar Industries, Inc.
   i. Seton Identification Products; a Brady Corporation company.
   j. emedco.

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, **1/8 inch (3.2 mm)** thick, with predrilled holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.

4. Maximum Temperature: Able to withstand temperatures of up to 160 deg F (71 deg C).
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
6. Minimum Letter Size: 3/4 inch (19 mm), gothic style text.
7. Fasteners: Stainless steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. Carlton Industries, LP.
3. Champion America.
4. Craftmark Pipe Markers.
5. LEM Products Inc.
6. Marking Services Inc.
7. National Marker Company.
8. Pipemarker.com; Brimar Industries, Inc.
9. Seton Identification Products; a Brady Corporation company.
10. Stranco, Inc.
11. emedco.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, **1/8 inch (3.2 mm)** thick, with predrilled holes for attachment hardware.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Maximum Temperature: Able to withstand temperatures of up to 160 deg F (71 deg C).

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless steel rivets or self-taping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA70E **and other applicable codes and standards**.

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Carlton Industries, LP.
4. Champion America.
5. Craftmark Pipe Markers.
6. Kolbi Pipe Marker Co.
7. LEM Products Inc.
8. Marking Services Inc.
9. Pipemarker.com; Brimar Industries, Inc.
10. Seton Identification Products; a Brady Corporation company.
11. emedco.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to **partially cover** circumference of pipe and to attach to pipe without fasteners or adhesive.

E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:

1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on distribution piping. Arrows may be either integral with label or applied separately.
3. Lettering Size: **1/2 inch (13 mm)** high **for pipe/insulation sizes up to and including 1-**1/4 inch diameter and 3/4 inch (19 mm) high for pipe/insulation sizes 1-1/2” to 2 inch diameter.

2.4 DUCT LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. Carlton Industries, LP.
3. Champion America.
4. Craftmark Pipe Markers.

5. Kolbi Pipe Marker Co.
6. LEM Products Inc.
7. Marking Services Inc.
8. Pipemarker.com; Brimar Industries, Inc.
9. Seton Identification Products; a Brady Corporation company.
10. emedco.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, **1/8 inch (3.2 mm)** thick, and having predrilled holes for attachment hardware.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings. Also include the following:

1. Duct size.
2. Flow-Direction Arrows: Include flow-direction arrows on distribution ducts. Arrows may be either integral with label or may be applied separately.
3. Lettering Size: **Size letters in accordance with ASME A13.1 for piping** and **At least 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm) and proportionately larger lettering for greater viewing distance**.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of mechanical equipment.

B. Sign and Label Colors:

1. **White letters on an ANSI Z535.1 safety-blue background**.

C. Locate equipment labels where accessible and visible.

D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E**, and other applicable codes and standards**.

3.4 INSTALLATION OF PIPE LABELS

A. Piping Color Coding: Painting of piping is specified in **Section 099123 "Interior Painting."**

B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

C. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within 3 ft. (1 m) of each valve and control device.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within 3 ft. (1 m) of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of **25 ft. (8 m)** along each run. Reduce intervals to **10 ft. (3.0 m)** in areas of congested piping, ductwork, and equipment.

D. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F (52 deg C) or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

E. Flow-Direction Arrows: Use arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

F. Pipe-Label Color Schedule:
1. Refrigerant Liquid Piping: **Black letters on an ANSI Z535.1 safety-yellow background** with designation “L”.
2. Refrigerant Suction Piping: **Black letters on an ANSI Z535.1 safety-yellow background** with designation “S”.

3. Air Conditioner Condensate: Black letters on an ANSI Z535.1 safety-green background with designation “COND”.
4. All others per ASME 13.1 and ANSI Z535.1 Standards.

3.5 INSTALLATION OF DUCT LABELS

A. Install **self-adhesive** duct labels showing service and flow direction with permanent adhesive on air ducts.

1. Provide labels in the following color codes:

a. For low pressure air supply ducts: **White letters on green background** with designation “SUPPLY”.
b. For low pressure air return ducts: **White letters on green background** with designation “RETURN”**.**
c. For low pressure outside air ducts: **White letters on green background** with designation “O.A.”.
d. For exhaust air ducts: **White letters on green background** with designation “EXH.”.
e. All others: White letters on green background with service designation.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Testing, Adjusting, and Balancing of Air Systems:

   a. Constant-volume air systems.
   b. Variable-air-volume systems.
2. Testing, adjusting, and balancing of equipment.
3. Procedures for exhaust hoods.
4. Duct leakage tests verification.
5. Pipe leakage tests verification.
6. HVAC-control system verification.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.3 ACTION SUBMITTALS

A. TAB Report: Documentation indicating that work complies with ASHRAE/IES 90.1.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within **30** days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within **60** days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.

C. Strategies and Procedures Plan: Within **60** days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.

D. System Readiness Checklists: Within **60** days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Specialists Qualifications, Certified by AABC:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
2. TAB Technician: Employee of the TAB specialist and certified by AABC.

B. TAB Specialists Qualifications, Certified by **NEBB or TABB**:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by **NEBB or TABB**.
2. TAB Technician: Employee of the TAB specialist and certified by **NEBB or TABB**.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

E. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.6 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums used for HVAC to verify that they are properly separated from adjacent areas and sealed.

F. Examine equipment performance data, including fan curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainer baskets are installed and clean.

K. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

L. Examine operating safety interlocks and controls on HVAC equipment.

M. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.

N. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
b. Duct systems are complete with terminals installed.
c. Volume, smoke, and fire dampers are open and functional.
d. Clean filters are installed.
e. Fans are operating, free of vibration, and rotating in correct direction.
f. Variable-frequency controllers' startup is complete and safeties are verified.
g. Automatic temperature-control systems are operational.
h. Ceilings are installed.
i. Windows and doors are installed.
j. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in **AABC's "National Standards for Total System Balance"** or **NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems"** and in this Section.

B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 230713 "Duct Insulation,"

Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in **inch-pound (IP)** units.

3.4 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:

1. Motors.
2. Fans and ventilators.
3. Furnaces.
4. Radiant heaters.
5. Unit heaters.
6. Condensing units.
7. Energy-recovery units.
8. Air-handling units.
9. Heating and ventilating units.
10. Heating-only makeup air units.
11. Dedicated outdoor-air units.
12. Packaged air conditioners.
13. Self-contained air conditioners.
14. Split-system air conditioners.
15. Heat pumps.
16. Valance heating and cooling units.
17. Coils.
18. Fan coil units.
19. Unit ventilators.
20. Radiators.
21. Convectors.
22. Finned-tube radiation heaters.
23. Radiant-heating **cables**, **piping**, **and panels**.
24. Humidifiers.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' Record drawings duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

   a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
   b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
   c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

2. Measure fan static pressures as follows:

   a. Measure static pressure directly at the fan outlet or through the flexible connection.
   b. Measure static pressure directly at the fan inlet or through the flexible connection.
   c. Measure static pressure across each component that makes up the air-handling system.
   d. Report artificial loading of filters at the time static pressures are measured.

3. Review Contractor-prepared shop drawings and Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from **Engineer** for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-

heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:

   a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
   b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
   c. When maximum airflow is correct, balance the air outlets downstream from terminal units.

d. Adjust controls so that terminal is calling for minimum airflow.
e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.

5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.

   a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
   b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow, so that connected total matches fan selection and simulates actual load in the building.
   c. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
   d. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

6. Measure fan static pressures as follows:

   a. Measure static pressure directly at the fan outlet or through the flexible connection.
   b. Measure static pressure directly at the fan inlet or through the flexible connection.
   c. Measure static pressure across each component that makes up the air-handling system.
   d. Report any artificial loading of filters at the time static pressures are measured.

7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

   a. Balance the return-air ducts and inlets.
   b. Verify that terminal units are meeting design airflow under system maximum flow.

8. Re-measure the inlet static pressure at the most critical terminal unit, and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls Contractor.
9. Verify final system conditions as follows:

   a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
   b. Re-measure and confirm that total airflow is within design.
   c. Re-measure final fan operating data, speed, volts, amps, and static profile.
   d. Mark final settings.
   e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
   f. Verify tracking between supply and return fans.

3.8 PROCEDURES FOR AIR-COOLED CONDENSING UNITS

A. Verify proper rotation of fan(s).

B. Measure and record entering- and leaving-air temperatures.

C. Measure and record entering and leaving refrigerant pressures.

D. Measure and record operating data of compressor(s), fan(s), and motors.

3.9 PROCEDURES FOR AIR-COOLED CONDENSERS

A. Verify proper rotation of fan(s).

B. Measure and record entering- and leaving-air temperatures.

C. Measure and record entering and leaving refrigerant pressures.

D. Measure and record operating data of fan(s) and motor(s).

3.10 PROCEDURES FOR EXHAUST HOODS

1. Welding Hoods:
   a. Measure and record airflow by duct traverse.
   b. Retain "Capture and Containment" Subparagraph below for assurance hood is operating as intended by design.
   c. Capture and Containment: Check each hood for proper capture and containment using a smoke-emitting device. Observe and report performance. Make adjustments to achieve optimum results.
   d. AHJ Tests: Conduct additional tests required by authorities having jurisdiction.

3.11 DUCT LEAKAGE TESTS

A. Witness the duct leakage testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.12 HVAC CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify HVAC control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.

7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.13 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan and equipment with fan(s).
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. TAB After Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the airflow rates and water flow rates by more than **5** percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is **5** percent or less, equipment adjustments are not required.
4. Balance each air outlet.

3.14 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: **Plus or minus 5 percent** If design value is less than 100 cfm (47 L/s), within 10 cfm (4.7 L/s).
2. Air Outlets and Inlets: **Plus or minus 5 percent<Insert value**. If design value is less than 100 cfm (47 L/s), within 10 cfm (4.7 L/s).

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.15 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.

B. Status Reports: Prepare **biweekly** progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.16 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:
1. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.

5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents, including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans performance forms, including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Heating coil, dry-bulb conditions.
    e. Face and bypass damper settings at coils.
    f. Fan drive settings, including settings and percentage of maximum pitch diameter.
    g. **Variable-frequency controller** settings for variable-air-volume systems.
    h. Settings for pressure controller(s).
    i. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Duct, outlet, and inlet sizes.
3. Balancing stations.
4. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units, include the following:

1. Unit Data:

    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches (mm), and bore.
    i. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
    j. Number, make, and size of belts.

k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and speed.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches (mm), and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm (L/s).
b. Total system static pressure in inches wg (Pa).
c. Fan speed.
d. Inlet and discharge static pressure in inches wg (Pa).
e. For each filter bank, filter static-pressure differential in inches wg (Pa).
f. Preheat-coil static-pressure differential in inches wg (Pa).
g. Cooling-coil static-pressure differential in inches wg (Pa).
h. Heating-coil static-pressure differential in inches wg (Pa).
i. List for each internal component with pressure-drop, static-pressure differential in inches wg (Pa).
j. Outdoor airflow in cfm (L/s).
k. Return airflow in cfm (L/s).
l. Outdoor-air damper position.
m. Return-air damper position.
n. **Vortex damper position**.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch (mm) o.c.
f. Make and model number.
g. Face area in sq. ft. (sq. m).
h. Tube size in NPS (DN).
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm (L/s).
b. Average face velocity in fpm (m/s).
c. Air pressure drop in inches wg (Pa).
d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).

f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
h. Water flow rate in gpm (L/s).
i. Water pressure differential in feet of head or psig (kPa).
j. Entering-water temperature in deg F (deg C).
k. Leaving-water temperature in deg F (deg C).
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig (kPa).
n. Refrigerant suction temperature in deg F (deg C).
o. Inlet steam pressure in psig (kPa).

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h (kW).
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and speed.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches (mm), and bore.
n. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).

2. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm (L/s).
b. Entering-air temperature in deg F (deg C).
c. Leaving-air temperature in deg F (deg C).
d. Air temperature differential in deg F (deg C).
e. Entering-air static pressure in inches wg (Pa).
f. Leaving-air static pressure in inches wg (Pa).
g. Air static-pressure differential in inches wg (Pa).
h. Low-fire fuel input in Btu/h (kW).
i. High-fire fuel input in Btu/h (kW).
j. Manifold pressure in psig (kPa).
k. High-temperature-limit setting in deg F (deg C).
l. Operating set point in Btu/h (kW).
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h (kW).

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

    a. System identification.
    b. Location.
    c. Coil identification.
    d. Capacity in Btu/h (kW).
    e. Number of stages.
    f. Connected volts, phase, and hertz.
    g. Rated amperage.
    h. Airflow rate in cfm (L/s).
    i. Face area in sq. ft. (sq. m).
    j. Minimum face velocity in fpm (m/s).

2. Test Data (Indicated and Actual Values):

    a. Heat output in Btu/h (kW).
    b. Airflow rate in cfm (L/s).
    c. Air velocity in fpm (m/s).
    d. Entering-air temperature in deg F (deg C).
    e. Leaving-air temperature in deg F (deg C).
    f. Voltage at each connection.
    g. Amperage for each phase.

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and size.
    e. Manufacturer's serial number.
    f. Arrangement and class.
    g. Sheave make, size in inches (mm), and bore.
    h. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).

2. Motor Data:

    a. Motor make, and frame type and size.
    b. Horsepower and speed.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches (mm), and bore.
    f. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
    g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

    a. Total airflow rate in cfm (L/s).
    b. Total system static pressure in inches wg (Pa).
    c. Fan speed.

d. Discharge static pressure in inches wg (Pa).
e. Suction static pressure in inches wg (Pa).

J. Round, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System fan and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F (deg C).
d. Duct static pressure in inches wg (Pa).
e. Duct size in inches (mm).
f. Duct area in sq. ft. (sq. m).
g. Indicated airflow rate in cfm (L/s).
h. Indicated velocity in fpm (m/s).
i. Actual airflow rate in cfm (L/s).
j. Actual average velocity in fpm (m/s).
k. Barometric pressure in psig (Pa).

K. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft. (sq. m).

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm (L/s).
b. Air velocity in fpm (m/s).
c. Preliminary airflow rate as needed in cfm (L/s).
d. Preliminary velocity as needed in fpm (m/s).
e. Final airflow rate in cfm (L/s).
f. Final velocity in fpm (m/s).
g. Space temperature in deg F (deg C).

L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.

d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm (L/s).
b. Entering-water temperature in deg F (deg C).
c. Leaving-water temperature in deg F (deg C).
d. Water pressure drop in feet of head or psig (kPa).
e. Entering-air temperature in deg F (deg C).
f. Leaving-air temperature in deg F (deg C).

M. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.17 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of **Construction Manager**.

B. **Construction Manager** shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either **10** percent of the total measurements recorded or the extent of measurements that can be accomplished in **a normal 8-hour business day**.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than **10** percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
2. If the second final inspection also fails, Owner may pursue others Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.18 ADDITIONAL TESTS

A. Within **90** days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed oven and warewash exhaust.
6. Indoor, exposed oven and warewash exhaust.
7. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
8. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
9. Outdoor, concealed supply and return.
10. Outdoor, exposed supply and return.

B. Related Requirements:

1. Section 230716 "HVAC Equipment Insulation."
2. Section 230719 "HVAC Piping Insulation."
3. Section 233113 "Metal Ducts" for duct liners.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. **All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.**

2.2 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials are applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Glass-Fiber Blanket: Mineral or Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 450 deg F (232 deg C) in accordance with ASTM C411. Comply with ASTM C553, Type II, and ASTM C1290, **Type II with factory-applied vinyl jacket** and **Type III with factory-applied FSK jacket** . Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong
   b. CertainTeed; SAINT-GOBAIN.
   c. Imcoa
   d. Johns Manville; a Berkshire Hathaway company.
   e. Knauf Insulation.
   f. Manson Insulation Inc.
   g. Owens Corning.
   h. Rubatex
   i. Schuller

G. Mineral Wool Blanket: Basalt volcanic rock-derived fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to 1200 deg F (650 deg C) in accordance with ASTM C447. Comply with ASTM C553.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Johns Manville; a Berkshire Hathaway company.
b. Owens Corning.
c. ROCKWOOL.

H. Glass-Fiber Board Insulation: Mineral or Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F (1.7 deg C) and 250 deg F (121 deg C) for jacketed and between 35 deg F (1.7 deg C) and 450 deg F (232 deg C) for unfaced in accordance with ASTM C411. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation **with factory-applied ASJ** or **with factory-applied FSK jacket**. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CertainTeed; SAINT-GOBAIN.
b. Johns Manville; a Berkshire Hathaway company.
c. Knauf Insulation.
d. Manson Insulation Inc.
e. Owens Corning.

I. Mineral Wool Board: Basalt volcanic rock-derived fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 1100 deg F (600 deg C) in accordance with ASTM C411. Comply with ASTM C612, Type III, unfaced.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Johns Manville; a Berkshire Hathaway company.
b. Owens Corning.
c. ROCKWOOL.

2.3 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.

c. Foster Brand; H. B. Fuller.
d. Mon-Eco Industries, Inc.
2. Adhesives shall have a VOC content of 80 g/L or less.

C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller.
d. Mon-Eco Industries, Inc.
2. Adhesives shall have a VOC content of 80 g/L or less.

D. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Dow Consumer Solutions.
b. Johns Manville; a Berkshire Hathaway company.
c. P.I.C. Plastics, Inc.
d. Proto Corporation.
e. Sekisui Voltek, LLC.
f. Speedline Corporation.
2. Adhesives shall have a VOC content of 80 g/L or less.

2.4 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates.
1. VOC content of 300 g/L or less.

B. Vapor-Retarder Mastic, Water Based, Interior Use: Suitable for indoor use on below ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Aeroflex USA.
b. Childers Brand; H. B. Fuller Construction Products.
c. Foster Brand; H. B. Fuller.
d. Knauf Insulation.
e. Vimasco Corporation.

2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).

4. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
5. Color: **White**.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Eagle Bridges - Marathon Industries.
   c. Foster Brand; H. B. Fuller.
   d. Knauf Insulation.
   e. Mon-Eco Industries, Inc.
   f. Vimasco Corporation.

2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm (0.66 metric perm) at manufacturer's recommended dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
4. Color: **White**.

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Eagle Bridges - Marathon Industries.
   c. Foster Brand; H. B. Fuller.
   d. Mon-Eco Industries, Inc.

2. Materials are compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. Color: Aluminum.
6. Sealants shall have a VOC content of 420 g/L or less.

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller.

2. Materials are compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. Color: White.

6. Sealants shall have a VOC content of 420 g/L or less.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perm) when tested in accordance with ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.
6. ASJ+: All-service jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII
7. PSK Jacket: Aluminum foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Johns Manville; a Berkshire Hathaway company.
   b. P.I.C. Plastics, Inc.
   c. Proto Corporation.
   d. Speedline Corporation.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: **White**.

D. Aluminum Jacket: Comply with ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Johns Manville; a Berkshire Hathaway company.
    b. RPR Products, Inc.

2. **Sheet and roll stock ready for shop or field sizing**.
3. Finish and thickness are indicated in field-applied jacket schedules.
4. Moisture Barrier for Indoor Applications: **1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**.
5. Moisture Barrier for Outdoor Applications: **3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**.

E. Self-Adhesive Outdoor Jacket (Asphaltic): 60-mil- (1.5-mm-) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with **stucco-embossed** aluminum-foil facing.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Foster Brand; H. B. Fuller.
    b. MFM Building Products Corp.
    c. Polyguard Products, Inc.

F. Self-Adhesive Indoor/Outdoor Jacket (Non-Asphaltic): Vapor barrier and waterproofing jacket for installation over insulation located aboveground outdoors or indoors. Specialized jacket has five layers of laminated aluminum and polyester film with low-temperature acrylic pressure-sensitive adhesive. Outer aluminum surface is coated with UV-resistant coating for protection from environmental contaminants.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. 3M.
    b. 3M Building and Construction.
    c. Foster Brand; H. B. Fuller.
    d. Ideal Tape Co., Inc., an American Biltrite Company.

2. Permeance: 0.00 perm as tested in accordance with ASTM F1249.
3. Flamespread/Smoke Developed: 25/50 as tested in accordance with ASTM E84.
4. Aluminum Finish: **Embossed**.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Mesh: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for ducts.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Industrial Adhesives and Tapes Division.
b. Aeroflex USA.
c. Avery Dennison Corporation, Specialty Tapes Division.
d. Ideal Tape Co., Inc., an American Biltrite Company.
e. Knauf Insulation.

2. Width: **3 inches (75 mm)**.
3. Thickness: **11.5 mils (0.29 mm)**.
4. Adhesion: **90 ounces force/inch (1.0 N/mm)** in width.
5. Elongation: **2** percent.
6. Tensile Strength: **40 lbf/inch (7.2 N/mm)** in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Industrial Adhesives and Tapes Division.
b. Avery Dennison Corporation, Specialty Tapes Division.
c. Ideal Tape Co., Inc., an American Biltrite Company.
d. Knauf Insulation.

2. Width: **3 inches (75 mm)**.
3. Thickness: **6.5 mils (0.16 mm)**.
4. Adhesion: **90 ounces force/inch (1.0 N/mm)** in width.
5. Elongation: **2** percent.
6. Tensile Strength: **40 lbf/inch (7.2 N/mm)** in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Industrial Adhesives and Tapes Division.
b. Ideal Tape Co., Inc., an American Biltrite Company.

2. Width: **2 inches (50 mm)**.
3. Thickness: **6 mils (0.15 mm)**.
4. Adhesion: **64 ounces force/inch (0.7 N/mm)** in width.
5. Elongation: **500** percent.
6. Tensile Strength: **18 lbf/inch (3.3 N/mm)** in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. 3M Industrial Adhesives and Tapes Division.
   b. Avery Dennison Corporation, Specialty Tapes Division.
   c. Ideal Tape Co., Inc., an American Biltrite Company.
   d. Knauf Insulation.
   e. Sekisui Voltek, LLC.

2. Width: **2 inches (50 mm)**.
3. Thickness: **3.7 mils (0.093 mm)**.
4. Adhesion: **100 ounces force/inch (1.1 N/mm)** in width.
5. Elongation: **5** percent.
6. Tensile Strength: **34 lbf/inch (6.2 N/mm)** in width.

2.10 SECUREMENTS

A. Aluminum Bands: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, **1/2 inch (13 mm)** wide with **wing seal or closed seal**.

B. Stainless steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.

C. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer application.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Johns Manville; a Berkshire Hathaway company.
   b. RPR Products, Inc.

D. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) AGM Industries, Inc.
2) Gemco.
3) Midwest Fasteners, Inc.
4) Nelson Stud Welding.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
c. Spindle: **Copper- or zinc-coated, low-carbon steel, or Aluminum** or **Stainless steel**, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Gemco.
2) Midwest Fasteners, Inc.

b. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
c. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, **galvanized-steel** or **aluminum**] or **stainless steel** sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) AGM Industries, Inc.
2) Gemco.
3) Midwest Fasteners, Inc.
4) Nelson Stud Welding.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

4. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) Gemco.
      2) Midwest Fasteners, Inc.

E. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

F. Wire: **0.062-inch (1.6-mm) soft-annealed, stainless steel**.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. C & F Wire Products.
      b. Johns Manville; a Berkshire Hathaway company.
      c. RPR Products, Inc.

2.11 CORNER ANGLES

A. PVC Corner Angles: **30 mils (0.8 mm)** thick, minimum 1 by 1 inch (25 by 25 mm), PVC in accordance with ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles:[**0.040 inch (1.0 mm)** thick, minimum 1 by 1 inch (25 by 25 mm), aluminum in accordance with ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with the Contract Documents.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at **4 inches (100 mm)** o.c.

   a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches (50 mm).
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 INSTALLATION OF GLASS-FIBER AND MINERAL-WOOL INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

B. Comply with manufacturer's written installation instructions.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for **100** percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
   b. On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
   e. Impale insulation over pins and attach speed washers.
   f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).

5. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

C. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for **100** percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
    b. On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches (300 mm) o.c. and at end joints.

3.6 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Comply with manufacturer's written installation instructions.

B. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

C. Insulate duct access panels and doors to achieve same fire rating as duct.

D. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

3.7 FINISHES

A. Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: **Two** finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless steel jackets.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to **one** location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed oven and warewash exhaust.
6. Indoor, exposed oven and warewash exhaust.
7. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
8. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
9. Outdoor, concealed supply and return.
10. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.10 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, Supply-Air Duct and Plenum Insulation: Mineral Fiber **blanket**, **1-1/2 inches (38 mm)** thick and **0.75 lb/cu. ft. (12 kg/cu. m)** nominal density.

B. Concealed, Return-Air Duct and Plenum Insulation: Mineral-Fiber blanket, **1-1/2 inches (38 mm)** thick and **0.75 lb/cu. ft. (12 kg/cu. m)** nominal density.

C. Concealed, Outdoor-Air Duct and Plenum Insulation: **Mineral-fiber blanket**, **2 inches (38 mm)** thick and **0.75 lb/cu. ft. (12 kg/cu. m)** nominal density.

D. Concealed, Exhaust-Air Duct and Plenum Insulation: **Mineral**-fiber **blanket**, **1-1/2 inches (38 mm)** thick and **0.75 lb/cu. ft. (12 kg/cu. m)** nominal density.

E. Exposed, Supply-Air Duct and Plenum Insulation: **Mineral-fiber blanket**, **1-1/2 inches (38 mm)** thick and **1.5 lb/cu. ft. (24 kg/cu. m)** nominal density.

F. Exposed, Return-Air Duct and Plenum Insulation: **Mineral-fiber blanket**, **1-1/2 inches (38 mm)** thick and **1.5 lb/cu. ft. (24 kg/cu. m)** nominal density.

G. Exposed, Outdoor-Air Duct and Plenum Insulation: **Mineral**-fiber **blanket**, **/2 inches (38 mm)** thick and **1.5 lb/cu. ft. (24 kg/cu. m)**nominal density.

H. Exposed, Exhaust-Air Duct and Plenum Insulation: **Mineral-fiber blanket**, **1-1/2 inches (38 mm)** thick and **1.5 lb/cu. ft. (24 kg/cu. m)** nominal density.

3.11 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:

1. None.
2. Aluminum, **Stucco Embossed**: **0.024 inch (0.61 mm)** thick.

D. Ducts and Plenums, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):

1. Aluminum, **Stucco Embossed**: **0.024 inch (0.61 mm)**thick.
2. <**Insert jacket type**>.

E. Ducts and Plenums, Exposed, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):

1. Aluminum, **Stucco Embossed** with **1-1/4-Inch- (32-mm-) Deep Corrugations** thick.
2. <**Insert jacket type**>.

END OF SECTION 230713

SECTION 230716 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating HVAC equipment that is not factory insulated.

B. Related Sections:

1. Section 230713 "Duct Insulation."
2. Section 230719 "HVAC Piping Insulation."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:
1. Product Data: For recycled content, including post-consumer and pre-consumber recycled content and cost.
2. Product Data: For adhesives, coatings and sealants, indicating VOC content.
3. Laboratory Test Reports: For adhesives, coatings and sealants, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

A. Material test reports.

B. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or craft training program**, certified by the Department of Labor, Bureau of Apprenticeship and Training**.

1.5 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

C. Coordinate installation and testing of heat tracing.

1.6 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. **All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.**

2.2 INSULATION MATERIALS

A. Comply with requirements in "Breeching Insulation Schedule," "Indoor Equipment Insulation Schedule," and "Outdoor, Aboveground Equipment Insulation Schedule" articles for where insulating materials are applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Owens Corning.

   2. Block Insulation: Type I.
   3. Special-Shaped Insulation: Type III.
   4. Board Insulation: Type IV.
   5. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
   6. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

G. Flexible Elastomeric Insulation: Closed-cell or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F (minus 57 deg C) and 220 deg F (104 deg C). Comply with ASTM C534/C534M, Type II, for sheet materials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Aeroflex USA.
b. Armacell LLC.
c. K-Flex USA.

H. Glass-Fiber Blanket: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 450 deg F (232 deg C) in accordance with ASTM C411. Comply with ASTM C553, Type II and ASTM C1290, **Type II with factory-applied vinyl jacket** and **Type III with factory-applied FSK jacket**. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CertainTeed; SAINT-GOBAIN.
b. Johns Manville; a Berkshire Hathaway company.
c. Knauf Insulation.
d. Manson Insulation Inc.
e. Owens Corning.

I. High-Temperature, Glass-Fiber Blanket: Glass fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to 1000 deg F (650 deg C). Comply with ASTM C553, Type V.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CertainTeed; SAINT-GOBAIN.
b. Johns Manville; a Berkshire Hathaway company.
c. Knauf Insulation.
d. Manson Insulation Inc.
e. Owens Corning.

J. Glass-Fiber Board: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F (1.7 deg C) and 250 deg F (121 deg C) for jacketed and between 35 deg F (1.7 deg C) and 450 deg F (232 deg C) for unfaced in accordance with ASTM C411. Comply with ASTM C612, Type IA or Type IB. Provide insulation **with factory-applied ASJ** or **with factory-applied FSK jacket**. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CertainTeed; SAINT-GOBAIN.
b. Johns Manville; a Berkshire Hathaway company.

c. Knauf Insulation.
d. Manson Insulation Inc.
e. Owens Corning.

K. High-Temperature, Glass-Fiber Board: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 1000 deg F (650 deg C) in accordance with ASTM C411. Comply with ASTM C612, Type III, unfaced.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CertainTeed; SAINT-GOBAIN.
b. Johns Manville; a Berkshire Hathaway company.
c. Knauf Insulation.
d. Manson Insulation Inc.
e. Owens Corning.

L. Glass-Fiber, Pipe and Tank: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F (1.7 deg C) and 850 deg F (454 deg C), in accordance with ASTM C411. Comply with ASTM C1393.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CertainTeed; SAINT-GOBAIN.
b. Johns Manville; a Berkshire Hathaway company.
c. Knauf Insulation.
d. Manson Insulation Inc.
e. Owens Corning.

2. Semirigid board material with factory-applied **ASJ** or **FSK** jacket.
3. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

M. Mineral Wool, Pipe and Tank: Mineral wool fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 1000 deg F (538 deg C), in accordance with ASTM C411. Comply with ASTM C1393.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Johns Manville; a Berkshire Hathaway company.
b. Owens Corning.
c. ROCKWOOL.

2. Semirigid board material with factory-applied **ASJ** or **FSK** jacket.
3. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.3 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F (minus 73 to plus 93 deg C).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller.

2. Adhesives shall have a VOC content of 80 g/L or less.

C. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Aeroflex USA.
   b. Armacell LLC.
   c. K-Flex USA.

2. Flame-spread index is 25 or less and smoke-developed index is 50 or less as tested in accordance with ASTM E84.
3. Wet Flash Point: Below 0 deg F (minus 18 deg C)
4. Service Temperature Range: 40 to 200 deg F (4 to plus 93 deg C).
5. Color: **Black**.
6. Adhesives shall have a VOC content of 80 g/L or less.

D. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller.
   c. Mon-Eco Industries, Inc.

2. Adhesives shall have a VOC content of 80 g/L or less.

E. ASJ Adhesive and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.

b. Foster Brand; H. B. Fuller.
c. Mon-Eco Industries, Inc.

2. Adhesives shall have a VOC content of 80 g/L or less.

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Johns Manville; a Berkshire Hathaway company.
b. P.I.C. Plastics, Inc.
c. Proto Corporation.
d. Speedline Corporation.
e. The Dow Chemical Company.

2. Adhesives shall have a VOC content of 80 g/L or less.

2.4 MASTICS AND COATINGS

A. Materials are compatible with insulation materials, jackets, and substrates.
1. VOC Content: 300 g/L or less..

B. Vapor-Retarder Mastic, Water-Based: Suitable for indoor and outdoor use on below-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.
c. Knauf Insulation.
d. Mon-Eco Industries, Inc.
e. Vimasco Corporation.

2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: **Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**.
4. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
5. Color: **White**.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.
c. Knauf Insulation.
d. Mon-Eco Industries, Inc.

e. Vimasco Corporation.

2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm (0.66 metric perms) at manufacturer's recommended dry film thickness.
3. Service Temperature Range: **Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**.
4. Color: **White**.

2.5 SEALANTS

A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.
1. VOC content of 420 g/L or less.

B. Joint Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.
c. Mon-Eco Industries, Inc.
d. Owens Corning.

2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: **Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C)**.
4. Color: White or gray.

C. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.
c. Mon-Eco Industries, Inc.

2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: Aluminum.

D. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.

2. Fire- and water-resistant, flexible, elastomeric sealant.

3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: White.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
4. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perm) when tested in accordance with ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C1136, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Metal Jacket:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Johns Manville; a Berkshire Hathaway company.
   b. RPR Products, Inc.

2. Aluminum Jacket: Comply with ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.

D. Self-Adhesive Outdoor Jacket (Asphaltic): 60-mil- (1.5-mm-) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with **stucco-embossed** aluminum-foil facing.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. MFM Building Products Corp.
   b. Polyguard Products, Inc.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Mesh: Approximately 4 oz./sq. yd. (114 g/sq. m) with a thread count of 5 strands by 5 strands/sq. in. (2 strands by 2 strands/sq. mm) for covering equipment.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.

B. Woven Polyester Mesh: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for equipment.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.
c. Vimasco Corporation.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Industrial Adhesives and Tapes Division.
b. Avery Dennison Corporation, Specialty Tapes Division.
c. Ideal Tape Co., Inc., an American Biltrite Company.
d. Knauf Insulation.

2. Width: **3 inches (75 mm)**.
3. Thickness: **11.5 mils (0.29 mm)**.
4. Adhesion: **90 ounces force/inch (1.0 N/mm)** in width.
5. Elongation: **2** percent.
6. Tensile Strength: **40 lbf/inch (7.2 N/mm)** in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Industrial Adhesives and Tapes Division.
b. Avery Dennison Corporation, Specialty Tapes Division.
c. Ideal Tape Co., Inc., an American Biltrite Company.
d. Knauf Insulation.

2. Width: **3 inches (75 mm)**.
3. Thickness: **6.5 mils (0.16 mm)**.
4. Adhesion: **90 ounces force/inch (1.0 N/mm)** in width.
5. Elongation: **2** percent.
6. Tensile Strength: **40 lbf/inch (7.2 N/mm)** in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. 3M Industrial Adhesives and Tapes Division.
   b. Ideal Tape Co., Inc., an American Biltrite Company.

2. Width: **2 inches (50 mm)**.
3. Thickness: **6 mils (0.15 mm)**.
4. Adhesion: **64 ounces force/inch (0.7 N/mm)** in width.
5. Elongation: **500** percent.
6. Tensile Strength: **18 lbf/inch (3.3 N/mm)**in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. 3M Industrial Adhesives and Tapes Division.
   b. Avery Dennison Corporation, Specialty Tapes Division.
   c. Ideal Tape Co., Inc., an American Biltrite Company.
   d. Knauf Insulation.

2. Width: **2 inches (50 mm)**.
3. Thickness: **3.7 mils (0.093 mm)**.
4. Adhesion: **100 ounces force/inch (1.1 N/mm)** in width.
5. Elongation: **5** percent.
6. Tensile Strength: **34 lbf/inch (6.2 N/mm)** in width.

2.10 SECUREMENTS

A. Bands:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Johns Manville; a Berkshire Hathaway company.
   b. RPR Products, Inc.

2. Stainless Steel: ASTM A240/A240M, **Type 304 or Type 316**; 0.015 inch (0.38 mm) thick, **1/2 inch (13 mm)** wide with **wing seal or closed seal**.

3. Aluminum: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, **1/2 inch (13 mm)**wide with **wing seal or closed seal**.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding; **0.106-inch- (2.6-mm-)** diameter shank, length to suit depth of insulation indicated.

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) AGM Industries, Inc.
      2) Gemco.
      3) Midwest Fasteners, Inc.
      4) Nelson Stud Welding.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding; **0.106-inch- (2.6-mm-)** diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) AGM Industries, Inc.
      2) CL WARD & Family Inc.
      3) Gemco.
      4) Midwest Fasteners, Inc.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) AGM Industries, Inc.
      2) Gemco.
      3) Midwest Fasteners, Inc.

   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
   c. Spindle: **Copper- or zinc-coated, low-carbon steel** or **Aluminum** or **Stainless steel**, fully annealed, 0.106-inch- (2.6-mm-) diameter shank; length to suit depth of insulation indicated.
   d. Adhesive: Recommended by hanger manufacturer. Use product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, **galvanized-steel** or **aluminum** or **stainless steel** sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) AGM Industries, Inc.
      2) Gemco.
      3) Midwest Fasteners, Inc.
      4) Nelson Stud Welding.

   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

D. Wire: **0.062-inch (1.6-mm) soft-annealed, stainless steel**.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. C & F Wire Products.
   b. Johns Manville; a Berkshire Hathaway company.
   c. RPR Products, Inc.

2.11 CORNER ANGLES

A. PVC Corner Angles: **30 mils (0.8 mm)** thick, minimum 1 by 1 inch (25 by 25 mm), PVC in accordance with ASTM D1784, Class 16354-C, white or color-coded to match adjacent surface.

B. Aluminum Corner Angles:**0.040 inch (1.0 mm)** thick, minimum 1 by 1 inch (25 by 25 mm), aluminum in accordance with ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14.

C. Stainless Steel Corner Angles: **0.024 inch (0.61 mm)** thick, minimum 1 by 1 inch (25 by 25 mm), stainless steel in accordance with ASTM A240/A240M, **Type 304 or Type 316**.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range of between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, and jackets, of thicknesses required for each item of equipment, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with the Contract Documents.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at **2 inches (50 mm)** or **4 inches (100 mm)** o.c.
4. For below-ambient services, apply vapor-barrier mastic over staples.
5. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

O. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.3 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. **Mineral-Fiber**, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive, anchor pins, and speed washers.

1. Apply adhesives in accordance with manufacturer's recommended coverage rates per unit area, for **100** percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16 inches (400 mm) o.c. in both directions.
    d. Do not compress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins, and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (150 mm) from each end. Install wire or cable between two circumferential girdles 12 inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches (75 mm).
8. Install insulation in removable and replaceable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply **10**0 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

3.4 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Install in accordance with manufacturer's written installation instructions and ASTM C1710.

B. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches (300 mm) o.c. and at end joints.

D. Where PVDC jackets are indicated, install as follows:

1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches (850 mm) or less. 33-1/2-inch- (850-mm-) circumference limit allows for 2-inch- (50-mm-) overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
2. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.6 FINISHES

A. Equipment Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: **Two** finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum jackets.

3.7 FIELD QUALITY CONTROL

A. Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspection.

C. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to **one** location(s) for each type of equipment defined in "Indoor Equipment Insulation Schedule" and "Outdoor, Aboveground Equipment Insulation Schedule" articles. For large equipment, remove only a portion adequate to determine compliance.

D. All insulation applications will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.8 EQUIPMENT INSULATION SCHEDULE, GENERAL

A. Insulation conductivity and thickness per pipe size comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.

B. Acceptable insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials is Contractor's option.

3.9 INDOOR EQUIPMENT INSULATION SCHEDULE

A. Insulate indoor and outdoor equipment that is not factory insulated.

END OF SECTION 230716

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulation for HVAC piping systems.

B. Related Requirements:

1. Section 230713 "Duct Insulation" for duct insulation.
2. Section 230716 "HVAC Equipment Insulation" for equipment insulation.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:
1. Product Data: For recycled content, indicating post-consumer and pre-consumer recycled content and cost.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material test reports.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or craft training program**, certified by the Department of Labor, Bureau of Apprenticeship and Training**.

1.5 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for

installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.6 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
   1. **All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.**

2.2 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Owens Corning.

   2. Preformed Pipe Insulation without Jacket: Type II, Class 1, unfaced.
   3. Preformed Pipe Insulation with Jacket: Type II, Class 2, with factory-applied **ASJ** jacket.
   4. Fabricated shapes in accordance with ASTM C450, ASTM C585, and ASTM C1639.

5. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

G. Flexible Elastomeric: Closed-cell, or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F (minus 57 deg C) and 220 deg F (104 deg C). Comply with ASTM C534/C534M, Type I for tubular materials, Type II, for sheet materials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Aeroflex USA.
b. Armacell LLC.
c. K-Flex USA.

H. Glass-Fiber, Preformed Pipe: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 850 deg F (454 deg C) in accordance with ASTM C411. Comply with ASTM C547.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Johns Manville; a Berkshire Hathaway company.
b. Knauf Insulation.
c. Manson Insulation Inc.
d. Owens Corning.

2. Preformed Pipe Insulation: Type I, Grade A **with factory-applied ASJ or with factory-applied ASJ-SSL**.
3. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
1. VOC content of 50 g/L or less.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F (minus 73 to plus 93 deg C).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Foster Brand; H. B. Fuller.

C. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Aeroflex USA.
b. Armacell LLC.
c. K-Flex USA.

2. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
3. Wet Flash Point: Below 0 deg F (minus 18 deg C).
4. Service Temperature Range: 40 to 200 deg F (4 to plus 93 deg C).
5. Color: **Black**.

D. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.
c. Mon-Eco Industries, Inc.

E. ASJ Adhesive and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.
c. Mon-Eco Industries, Inc.

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Johns Manville; a Berkshire Hathaway company.
b. P.I.C. Plastics, Inc.
c. Proto Corporation.
d. Sekisui Voltek, LLC.
e. Speedline Corporation.
f. The Dow Chemical Company.

2.4 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates.
1. VOC Content 300 g/L or less.

B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Aeroflex USA.

b. Childers Brand; H. B. Fuller Construction Products.
c. Foster Brand; H. B. Fuller.
d. Knauf Insulation.
e. Mon-Eco Industries, Inc.
f. Vimasco Corporation.

2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: **Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**.
4. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
5. Color: **White**.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.
c. Knauf Insulation.
d. Mon-Eco Industries, Inc.
e. Vimasco Corporation.

2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm (0.66 metric perm) at manufacturer's recommended dry film thickness.
3. Service Temperature Range: **Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**.
4. Color: **White**.

2.5 SEALANTS

A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.
1. VOC content of 420 g/L or less.

B. Joint Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller.
c. Mon-Eco Industries, Inc.
d. Owens Corning.

2. Permanently flexible, elastomeric sealant.

a. Service Temperature Range: **Minus 150 to plus 250 deg F (Minus 101 to plus 121 deg C)**.
b. Color: White or gray.

C. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller.
   c. Mon-Eco Industries, Inc.

2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: Aluminum.

D. ASJ Flashing Sealants and PVDC and PVC Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller.

2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: White.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
4. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
5. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C1136, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Airex Manufacturing Inc.
    b. Johns Manville; a Berkshire Hathaway company.
    c. P.I.C. Plastics, Inc.
    d. Proto Corporation.
    e. Speedline Corporation.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: **White**.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

    a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Metal Jacket:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Johns Manville; a Berkshire Hathaway company.
    b. RPR Products, Inc.

2. Aluminum Jacket: Comply with ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.

    a. **Sheet and roll stock ready for shop or field sizing**.
    b. Finish and thickness are indicated in field-applied jacket schedules.
    c. Moisture Barrier for Outdoor Applications: **3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.**
    d. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Self-Adhesive Outdoor Jacket (Asphaltic): 60-mil- (1.5-mm-) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with **stucco-embossed** aluminum-foil facing.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. MFM Building Products Corp.
   b. Polyguard Products, Inc.

2.8 FIELD-APPLIED REINFORCING MESH

A. Woven Glass-Fiber Mesh: Approximately 2 oz./sq. yd. (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Childers Brand; H. B. Fuller Construction Products.

B. Woven Polyester Mesh: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for pipe.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller.
   c. Vimasco Corporation.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. 3M Industrial Adhesives and Tapes Division.
   b. Aeroflex USA.
   c. Avery Dennison Corporation, Specialty Tapes Division.
   d. Ideal Tape Co., Inc., an American Biltrite Company.
   e. Knauf Insulation.

2. Width: **3 inches (75 mm)**.
3. Thickness: **11.5 mils (0.29 mm)**.
4. Adhesion: **90 ounces force/inch (1.0 N/mm)** in width.
5. Elongation: **2** percent.
6. Tensile Strength: **40 lbf/inch (7.2 N/mm)** in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. 3M Industrial Adhesives and Tapes Division.
    b. Avery Dennison Corporation, Specialty Tapes Division.
    c. Ideal Tape Co., Inc., an American Biltrite Company.
    d. Knauf Insulation.

2. Width: **3 inches (75 mm)**.
3. Thickness: **6.5 mils (0.16 mm)**.
4. Adhesion: **90 ounces force/inch (1.0 N/mm)** in width.
5. Elongation: **2** percent.
6. Tensile Strength: **40 lbf/inch (7.2 N/mm)** in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. 3M Industrial Adhesives and Tapes Division.
    b. Ideal Tape Co., Inc., an American Biltrite Company.

2. Width: **2 inches (50 mm)**.
3. Thickness: **6 mils (0.15 mm)**.
4. Adhesion: **64 ounces force/inch (0.7 N/mm)** in width.
5. Elongation: **500** percent.
6. Tensile Strength: **18 lbf/inch (3.3 N/mm)** in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. 3M Industrial Adhesives and Tapes Division.
    b. Avery Dennison Corporation, Specialty Tapes Division.
    c. Ideal Tape Co., Inc., an American Biltrite Company.
    d. Knauf Insulation.

2. Width: **2 inches (50 mm)**.
3. Thickness: **3.7 mils (0.093 mm)**.
4. Adhesion: **100 ounces force/inch (1.1 N/mm)** in width.
5. Elongation: **5** percent.
6. Tensile Strength: **34 lbf/inch (6.2 N/mm)** in width.

2.10 SECUREMENTS

A. Bands:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Johns Manville; a Berkshire Hathaway company.
   b. RPR Products, Inc.

2. Stainless Steel: ASTM A240/A240M, **Type 304 or Type 316**; 0.015 inch (0.38 mm) thick, **1/2 inch (13 mm)** wide with **wing seal or closed seal**.
3. Aluminum: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, **1/2 inch (13 mm)** wide with **wing seal or closed seal**.
4. Springs: Twin spring set constructed of stainless steel, with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4 inch (19 mm) wide, stainless steel or Monel.

C. Wire: **0.062-inch (1.6-mm) soft-annealed, galvanized steel**.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. C & F Wire Products.
   b. Johns Manville; a Berkshire Hathaway company.
   c. RPR Products, Inc.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with the Contract Documents.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at **2 inches (50 mm)** or **4 inches (100 mm)** o.c.
4. For below-ambient services, apply vapor-barrier mastic over staples.
5. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least **4 inches (100 mm)** beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles below.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using **prefabricated fitting insulation or mitered or routed fittings** made from same material and density as that of adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with **prefabricated fitting insulation or sectional pipe insulation** of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using **prefabricated fitting insulation or sectional pipe insulation** of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using **prefabricated fitting insulation or sectional pipe insulation** of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and

replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges, mechanical couplings, and unions using a section of oversized preformed pipe insulation to fit. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches (150 mm) o.c.
4. For insulation with jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered or routed sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated valve covers manufactured of same material as that of pipe insulation when available.
2. When prefabricated valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF GLASS-FIBER AND MINERAL WOOL INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches (150 mm) o.c.
4. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral-wool blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated sections are not available, install fabricated sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF FIELD-APPLIED JACKETS

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated and for horizontal applications, install with 1-inch (25-mm) overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches (300 mm) o.c. and at end joints.

3.9 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: **Two** finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless steel jackets.

3.10 FIELD QUALITY CONTROL

A. Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to **thre**e locations of straight pipe, **three** locations of threaded fittings, **three** locations of welded fittings, **two** locations of threaded strainers, **two** locations of welded strainers, **three** locations of threaded valves, and **three** locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.11 PIPING INSULATION SCHEDULE, GENERAL

A. Insulation conductivity and thickness per pipe size shall comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.

B. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.12 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):

1. All Pipe Sizes: Insulation shall be **one of** the following:
   a. Flexible Elastomeric: **1 inch (25 mm)** thick.
   b. Glass-Fiber, Preformed Pipe Insulation, Type I: **1/2 inch (13 mm)** thick.

B. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be **one of** the following:
   a. Flexible Elastomeric: **1 inch (25 mm)** thick.

C. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be **one of** the following:

a. Flexible Elastomeric: **2 inches (50 mm)** thick.

D. Refrigerant Liquid Piping:

1. All Pipe Sizes: Insulation shall be the following:
a. Flexible Elastomeric: **1 inch (25 mm)**> thick.

3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be **one of** the following:
a. Flexible Elastomeric: **2 inches (50 mm)** thick.

B. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation is the following:

a. Flexible Elastomeric: **2 inches (50 mm)** thick.

C. Refrigerant Liquid Piping:

1. All Pipe Sizes: Insulation shall be **one of** the following:

a. Flexible Elastomeric: **1 inch (25 mm)** thick.
b. .

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.
2. Exception: Refrigerant Piping - none.

D. Piping, Exposed:

1. None.
2. Exception: Refrigerant Piping - none.

3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.
2. Exception: Refrigerant Piping - none.

D. Piping, Exposed:
1. Exception: Refrigerant Piping - none.

END OF SECTION 230719

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Valves and specialties.
3. Refrigerants.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Strainers.
4. Filter dryers.
5. Pressure-regulating valves.

B. Product Data Submittals: For each product.

1. Submit data for each type of refrigerant piping, fitting, valve, piping specialty, and refrigerant.

C. Delegated Design Submittals: For refrigerant piping size and layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

D. Shop Drawings:

1. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
2. Show interface and spatial relationships between piping and equipment.
3. Shop Drawing Scale: **1/4 inch equals 1 foot (1:50)**.

1.3 INFORMATIONAL SUBMITTALS

A. Welding Certificates: For each welder performing shop or field welding on Project.

B. Field Quality-Control Reports: For each field quality control test and inspection.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with ASME Boiler and Pressure Vessel Code: Section IX, "Welding, Brazing, and Fusing Qualifications."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," for refrigerant piping size and layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

B. Comply with ASHRAE 15.

C. Comply with ASME B31.5.

D. Line Test Pressure for Refrigerant R-32 or 454B:

1. Suction Lines for Refrigeration and Air-Conditioning Applications Other than Heat Pumps: **300 psig (2068 kPa)**.
2. Suction Lines for Heat-Pump Applications: **535 psig (3689 kPa)**.
3. Hot-Gas and Liquid Lines: **535 psig (3689 kPa)**.

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: **ASTM B280, Type ACR**.

B. Wrought-Copper Fittings, Solder Joint: ASME B16.22.

C. Wrought-Copper Fittings, Brazed Joint: ASME B16.50.

D. Wrought-Copper Unions: ASME B16.22.

E. Solder Filler Metals: ASTM B32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

F. Brazing Filler Metals: AWS A5.8M/A5.8.

G. Brazing Alloy

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Handy Harmon; Sil-Fos
   b. Airco Welding Products; Aircosil
   c. ESAB Allstate

2. 45% silver/phosphorous or silver/zinc allow with a melting point greater than 1,000 deg F.

H. Flexible Connectors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Metraflex
   b. Flexonics
   c. Flexicraft
   d. Hyspan Precision Products

2. Corrugated stainless steel inner tube with braided outer shield, sweat connections.
3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
4. Working Pressure Rating: Factory test at minimum **500 psig (3450 kPa)**.
5. Maximum Operating Temperature: **250 deg F (121 deg C)**.

2.3 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Danfoss, Inc.
   b. Henry Technologies Inc.; The Henry Group.
   c. Parker (Parker Hannifin).

2. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
3. Diaphragm: Phosphor bronze and stainless steel with stainless steel spring.
4. Operator: Rising stem and hand wheel.
5. Seat: Nylon.
6. End Connections: Socket, union, or flanged.
7. Working Pressure Rating: **500 psig (3450 kPa)**.
8. Maximum Operating Temperature: **240 deg F (116 deg C)**.

B. Packed-Angle Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Danfoss, Inc.

b. Henry Technologies Inc.; The Henry Group.
c. Parker (Parker Hannifin).

2. Body and Bonnet: Forged brass or cast bronze.
3. Packing: Molded stem, back seating, and replaceable under pressure.
4. Operator: Rising stem.
5. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
6. Seal Cap: Forged-brass or valox hex cap.
7. End Connections: Socket, union, threaded, or flanged.
8. Working Pressure Rating: **500 psig (3450 kPa)**.
9. Maximum Operating Temperature: **275 deg F (135 deg C)**.

C. Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Danfoss, Inc.
c. Henry Technologies Inc.; The Henry Group.
d. Parker (Parker Hannifin).

2. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
3. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
4. Piston: Removable polytetrafluoroethylene seat.
5. Closing Spring: Stainless steel.
6. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
7. End Connections: Socket, union, threaded, or flanged.
8. Maximum Opening Pressure: 0.50 psig (3.4 kPa).
9. Working Pressure Rating: **500 psig (3450 kPa)**.
10. Maximum Operating Temperature: **275 deg F (135 deg C)**>.

D. Service Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Henry Technologies Inc.; The Henry Group.; Type 203

2. Body: Forged brass with brass cap, including key end to remove core.
3. Core: Removable ball-type check valve with stainless steel spring.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Copper spring.
6. Working Pressure Rating: **500 psig (3450 kPa)**.
7. Maximum Operating Temperature: **275 deg F (135 deg C)**.

E. Refrigerant Locking Caps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. C & D Valve, LLC.

b. JB Industries.
c. RectorSeal HVAC; a CSW Industrials Company.
d. Refrigeration Sales, Inc.

2. Description: Locking-type, tamper-resistant, threaded caps to protect refrigerant-charging ports from unauthorized refrigerant access and leakage.
3. Material: Brass, with protective shroud or sleeve.
4. Refrigerant Identification: **Color-coded, refrigerant specific based on AHRI Guideline N or Universal** design.
5. Special Tool: For installing and unlocking.

F. Solenoid Valves: Comply with AHRI 760 I-P (AHRI 761 SI) and UL 429; listed and labeled by an NRTL.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Danfoss, Inc.
b. Henry Technologies Inc.; The Henry Group.
c. Parker (Parker Hannifin).

2. Body and Bonnet: Plated steel.
3. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Threaded.
6. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-mm) conduit adapter, and **24**, **115** or **208** V ac coil.
7. Working Pressure Rating: **400 psig (2760 kPa)**.
8. Maximum Operating Temperature: **240 deg F (116 deg C)**.

G. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Danfoss, Inc.
b. Henry Technologies Inc.; The Henry Group.
c. Parker (Parker Hannifin).

2. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
3. Piston, Closing Spring, and Seat Insert: Stainless steel.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Threaded.
6. Working Pressure Rating: **400 psig (2760 kPa)**.
7. Maximum Operating Temperature: **240 deg F (116 deg C)**.

H. Thermostatic Expansion Valves: Comply with AHRI 750 I-P (AHRI 751 SI).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Danfoss, Inc.
b. Henry Technologies Inc.; The Henry Group.
c. Parker Hannifin; Sporlan Division (Zoomlock).

2. Body, Bonnet, and Seal Cap: Forged brass or steel.
3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
4. Packing and Gaskets: Non-asbestos.
5. Capillary and Bulb: Copper tubing filled with refrigerant charge.
6. Suction Temperature: **40 deg F (4.4 deg C)**.
7. Superheat: **Adjustable**.
8. Reverse-flow option (for heat-pump applications).
9. End Connections: Socket, flare, or threaded union.
10. Working Pressure Rating:**450 psig (3100 kPa)**.

I. Straight-Type Strainers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Danfoss, Inc.
b. Henry Technologies Inc.; The Henry Group.
c. Parker (Parker Hannifin).

2. Body: Welded steel with corrosion-resistant coating.
3. Screen: 100-mesh stainless steel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: **500 psig (3450 kPa)**.
6. Maximum Operating Temperature: **275 deg F (135 deg C)**.

J. Angle-Type Strainers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Danfoss, Inc.
b. Henry Technologies Inc.; The Henry Group.
c. Parker (Parker Hannifin).

2. Body: Forged brass or cast bronze.
3. Drain Plug: Brass hex plug.
4. Screen: 100-mesh monel.
5. End Connections: Socket or flare.
6. Working Pressure Rating: **500 psig (3450 kPa)**.
7. Maximum Operating Temperature: **275 deg F (135 deg C)**.

K. Moisture/Liquid Indicators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Danfoss, Inc.

b. Henry Technologies Inc.; The Henry Group.
c. Parker (Parker Hannifin).
d. RLS LLC.

2. Body: Forged brass.
3. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
4. Indicator: Color-coded to show moisture content in parts per million (ppm).
5. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
6. End Connections: Socket or flare.
7. Working Pressure Rating: **500 psig (3450 kPa)**.
8. Maximum Operating Temperature: **240 deg F (116 deg C)**.

L. Replaceable-Core Filter Dryers: Comply with AHRI 730 I-P (AHRI 731 SI).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Danfoss, Inc.
b. Henry Technologies Inc.; The Henry Group.
c. Parker (Parker Hannifin).

2. Body and Cover: Painted-steel shell with ductile-iron cover, stainless steel screws, and neoprene gaskets.
3. Filter Media: 10 micron, pleated with integral end rings; stainless steel support.
4. Desiccant Media: Activated **alumina** or **charcoal**.
5. Design: Reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
8. Maximum Pressure Loss: **2 psig (14 kPa)**.
9. Working Pressure Rating: **500 psig (3450 kPa)**.
10. Maximum Operating Temperature: **240 deg F (116 deg C)**.

M. Permanent Filter Dryers: Comply with AHRI 730 I-P (AHRI 731 SI).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Danfoss, Inc.
b. Henry Technologies Inc.; The Henry Group.
c. Parker (Parker Hannifin).
d. RLS LLC.

2. Body and Cover: Painted-steel shell.
3. Filter Media: 10 micron, pleated with integral end rings; stainless steel support.
4. Desiccant Media: Activated **alumina** or **charcoal**.
5. Design: Reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.

8. Maximum Pressure Loss: **2 psig (14 kPa)**.
9. Working Pressure Rating: **500 psig (3450 kPa)**.
10. Maximum Operating Temperature: **240 deg F (116 deg C)**.

2.4 REFRIGERANTS

A. R-32 or 454B, ASHRAE 34: Hydrofluoroolefin/Difluoromethane.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Arkema Inc.
b. DuPont Fluorochemicals Div.
c. Genetron Refrigerants; Honeywell International Inc.
d. Mexichem Fluor, Inc. (Koura).

PART 3 - EXECUTION

3.1 PIPING APPLICATION SCHEDULES **R-32 or R-454B**

A. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with **brazed or soldered** joints.

B. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 4 (DN 100) and Smaller: Copper, **Type ACR**, drawn-temper tubing and wrought-copper fittings with **brazed or soldered** joints.

C. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 2 to NPS 4 (DN 50 to DN 100): Copper, **Type ACR**, drawn-temper tubing and wrought-copper fittings with **brazed or soldered** joints.

D. Safety-Relief-Valve Discharge Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, Copper: **Type ACR drawn-temper** tubing and wrought-copper fittings with **brazed or soldered** joints.

E. Safety-Relief-Valve Discharge Piping for Conventional Air-Conditioning (Cooling-Only) Applications, Steel: Schedule 40, black steel and wrought-steel fittings with welded joints.

F. Suction, Hot-Gas, and Liquid Tubing for Heat-Pump Applications, NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with **brazed or soldered** joints.

G. Suction, Hot-Gas, and Liquid Tubing for Heat-Pump Applications, NPS 4 (DN 100) and Smaller: Copper, **Type ACR**, drawn-temper tubing and wrought-copper fittings with **brazed or soldered** joints.

H. Suction, Hot-Gas, and Liquid Tubing for Heat-Pump Applications, NPS 2 to NPS 4 (DN 50 to DN 100): Copper, **Type ACR**, drawn-temper tubing and wrought-copper fittings with **brazed or soldered** joints.

I. Safety-Relief-Valve Discharge Tubing for Heat-Pump Applications, Copper: **Type ACR**, **drawn-temper** tubing and wrought-copper fittings with **brazed or soldered** joints.

J. Safety-Relief-Valve Discharge Piping for Heat-Pump Applications, Steel: Schedule 40, black steel and wrought-steel fittings with welded joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install **diaphragm packless** or **packed-angle** valves in suction and discharge lines of compressor.

B. Install service valves for gauge taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install **diaphragm packless** or **packed-angle** valves on inlet and outlet side of filter dryers.

E. Install a full-size, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety-relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside in accordance with ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve**, and in the suction line at the compressor**.

L. Install flexible connectors at compressors.

M. Provide refrigerant locking caps on refrigerant charging ports that are located outdoors unless otherwise protected from unauthorized access by a means acceptable to authority having jurisdiction.

3.3 INSTALLATION OF PIPING, GENERAL

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping in accordance with ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Install refrigerant piping in protective conduit where installed belowground.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation. Refer to section 23 07 19 “HVAC Piping Insulation”.

Q. Identify refrigerant piping and valves in accordance with Section 230553 "Identification for HVAC Piping and Equipment."

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints in accordance with ASTM B828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints in accordance with AWS BRH, "Brazing Handbook," Ch. 35, "Pipe and Tubing."

1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

F. Threaded Joints: Thread steel pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and to restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic restraints in Section 230548.13 "Vibration Controls for HVAC."

B. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 ft. (6 m) long.
2. Roller hangers and spring hangers for individual horizontal runs 20 ft. (6 m) or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 ft. (6 m) or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

D. Install hangers for copper tubing with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping within **12 inches (300 mm)** of each fitting.

F. Support vertical runs of copper tubing to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: **Engage** a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.

    a. Fill system with nitrogen to the required test pressure.
    b. System must maintain test pressure at the manifold gauge throughout duration of test.

c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

C. Prepare test and inspection reports.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
4. Charge system with a new filter-dryer core in charging line.

B. Option: Pre-Charged, pre-insulated line set.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, in accordance with manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves but not bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.

B. Related Requirements:

1. Section 230548.13 "Vibration Controls for HVAC" for restraint devices and installation.
2. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
3. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top **and bottom** of ducts.
5. Dimensions of **all** duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.

12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Delegated Design Submittals:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Welding certificates.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. **AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.**
2. **AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.**
3. **AWS D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.**

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports are to withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" **and ASCE/SEI 7** and Ohio Building Code.

C. Retain "Wind Performance" Paragraph below with "Product Certificates" Paragraph in "Informational Submittals" Article for project requiring wind-restraint design. Delete paragraph if performance requirements are indicated on Drawings. Model building codes and ASCE/SEI 7 establish criteria for building equipment subject to wind effects. Coordinate requirements with structural engineer.

D. Wind Performance: Ducts are to withstand the effects of wind determined in accordance with to **ASCE/SEI 7**.

E. Airstream Surfaces: Surfaces in contact with airstream comply with requirements in ASHRAE 62.1.

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

G. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

H. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.
2. For ducts exposed to weather, construct of **Type 304** or **Type 316** stainless steel indicated by manufacturer to be suitable for outdoor installation.

B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. For ducts with longest side less than 36 inches (914 mm), select joint types in accordance with Figure 2-1.
2. For ducts with longest side 36 inches (914 mm) or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
3. **Where specified for specific applications, all joints are to be welded.**

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." **All longitudinal seams are to be Pittsburgh lock seams unless otherwise specified for specific application.**

1. **Where specified for specific applications, all joints are to be welded.**

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing

requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.
2. For ducts exposed to weather, construct of **Type 304** or **Type 316** stainless steel indicated by manufacturer to be suitable for outdoor installation.

3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Elgen Manufacturing.
   b. GreenSeam.
   c. Linx Industries; a DMI company (formerly Lindab).
   d. MKT Metal Manufacturing.
   e. McGill AirFlow LLC.
   f. Nordfab Ducting.
   g. SEMCO, LLC; part of FlaktGroup.
   h. SHAPE Manufacturing Inc.
   i. Set Duct Manufacturing.
   j. Sheet Metal Connectors, Inc.
   k. Spiral Manufacturing Co., Inc.
   l. Stamped Fittings Inc.
   m. Tuttle & Bailey
   n. Ductmate Industries, Inc; a DMI company.

B. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than **60 (1524)** in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials are to be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: **G90 (Z275)**.
2. Finishes for Surfaces Exposed to View: Coated with Glidden #5229 galvanized primer or provided with “paint grip” primer by Contractor for field painting. Provide (primed) sheet metal escutcheons wherever ductwork penetrates a finished wall surface.

C. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.

D. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, as indicated in "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish is to be No. 2B, No. 2D, No. 3, or No. 4 as indicated in "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B209 (ASTM B209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

G. Tie Rods: Galvanized steel, 1/4-inch- (6-mm-) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch- (10-mm-) minimum diameter for lengths longer than 36 inches (900 mm).

2.5 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CertainTeed; SAINT-GOBAIN.
b. Johns Manville; a Berkshire Hathaway company.
c. Knauf Insulation.
d. Owens Corning.
e. Sekisui Voltek, LLC.

2. Maximum Thermal Conductivity:

a. Type I, Flexible: **0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K)** at 75 deg F (24 deg C) mean temperature.
b. Type II, Rigid: **0.23 Btu x in./h x sq. ft. x deg F (0.033 W/m x K)** at 75 deg F (24 deg C) mean temperature.

3. **Water**-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.
a. Adhesive shall have a VOC of 80 g/L or less.

B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C534/C534M, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Aeroflex USA.
b. Armacell LLC.
c. K-Flex USA.
d. Sekisui Voltek, LLC.

2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
a. Adhesive shall have a VOC of 80 g/L or less.

C. Fibrous-Glass-Free, Natural-Fiber Duct Liner: Made from partially recycled cotton or polyester products and containing no fiberglass. Airstream surface overlaid with fire-resistant facing to prevent surface erosion by airstream, complying with NFPA 90A or NFPA 90B. Treat natural-fiber products with antimicrobial coating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Acoustical Surfaces, Inc.
b. Ductmate Industries, Inc; a DMI company.

2. Maximum Thermal Conductivity: **0.24 Btu x in./h x sq. ft. x deg F (0.034 W/m x K)** at 75 deg F (24 deg C) mean temperature when tested in accordance with ASTM C518.
3. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with ASTM E84; certified by an NRTL.
4. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
a. Adhesive shall have a VOC of 80 g/L or less.

D. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, **0.106-inch- (2.6-mm-)** or**0.135-inch- (3.5-mm-)** diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick **galvanized steel**; with beveled edge sized as required to hold insulation securely in place, but not less than 1-1/2 inches (38 mm) in diameter.

E. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm (12.7 m/s) or greater.
7. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm (12.7 m/s) or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

    a. Sheet Metal Inner Duct Perforations: 3/32-inch (2.4-mm) diameter, with an overall open area of 23 percent.

10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.6 SEALANT AND GASKETS

A. Duct Sealer Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Foster.
   b. Hardcast
   c. United McGill Corporation

B. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets are to be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

C. Two-Part Tape Sealing System:

   1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
   2. Tape Width: **3 inches (76 mm)**.
   3. Sealant: Modified styrene acrylic.
   4. Water resistant.
   5. Mold and mildew resistant.
   6. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
   7. Service: Indoor and outdoor.
   8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
   10. Sealant shall have a VOC of 420 g/L or less.

D. Water-Based Joint and Seam Sealant:

   1. Application Method: Brush on.
   2. Solids Content: Minimum 65 percent.
   3. Shore A Hardness: Minimum 20.
   4. Water resistant.
   5. Mold and mildew resistant.
   6. VOC: Maximum 75 g/L (less water).
   7. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
   8. Service: Indoor or outdoor.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
   10. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive or negative.
   11. Service: Indoor or outdoor.
   12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C920.

   1. General: Single-component, acid-curing, silicone, elastomeric.
   2. Type: S.
   3. Grade: NS.
   4. Class: 25.

5. Use: O.
6. Sealant shall have a VOC content of 420 g/L or less.

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal is to provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and is to be rated for 10-inch wg (2500-Pa) static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.7 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.

E. Steel Cables for Stainless Steel Ducts: Stainless steel complying with ASTM A492.

F. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless Steel Ducts: Stainless steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations.

Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts in maximum practical lengths with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).

J. Install fire**, combination fire/smoke,** and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers and specific installation requirements of the damper UL listing.

K. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation. **Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."**

M. Elbows: Use long-radius elbows wherever they fit.

1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches (300 mm) and smaller and a minimum of five segments for 14 inches (350 mm) and larger.

N. Branch Connections: Use lateral or conical branch connections.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR EXHAUST DUCTS SERVING HIGH-HUMIDITY LOCATIONS (WASHBAY)

A. Install exhaust ducts from wet, high-humidity locations without dips and traps that may water. Slope ducts a minimum of 2 percent back toward drain.

B. Provide a drain pocket at each low point and at the base of each riser with a 1-inch (25-mm) trapped copper drain from each drain pocket to open site floor drain.

C. Minimize number of transverse seams.

D. Do not locate longitudinal seams on bottom of duct.

3.4 DUCTWORK EXPOSED TO WEATHER

A. All external joints are to **have secure watertight mechanical connections**. Seal all openings to provide weatherproof construction.

B. Construct ductwork to resist external loads of wind, snow, ice, and other effects of weather. Provide necessary supporting structures.

C. Single Wall:

1. Ductwork is to be **Type 304** or **Type 316** stainless steel.
2. Ductwork is to be galvanized steel.

    a. If duct outer surface is uninsulated, protect outer surface with suitable paint. Paint materials and application requirements are specified in Section 099113 "Exterior Painting."

3. Where ducts have external insulation, provide weatherproof aluminum jacket. See Section 230713 "Duct Insulation."

3.5 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints. Coordinate with Section 230548 "Vibration and Seismic Controls for HVAC."

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1220 mm) of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (5 m).

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.7 RESTRAINT-DEVICE INSTALLATION

A. See Section 230548.13 "Vibration Controls for HVAC" for restraint installation requirements.

3.8 DUCTWORK CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.9 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

   a. Ducts with a Pressure Class Higher Than 3-Inch wg (750 Pa): Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
   b. Supply Ducts with a Pressure Class of **2- (500)** Inch wg (Pa) or Higher: Test representative duct sections totaling no less than **50** percent of total installed duct area for each designated pressure class.
   c. Return Ducts with a Pressure Class of **2- (500)** Inch wg (Pa) or Higher: Test representative duct sections totaling no less than **50** percent of total installed duct area for each designated pressure class.

d. Exhaust Ducts with a Pressure Class of **2- (500)** Inch wg (Pa) or Higher: Test representative duct sections totaling no less than **50** percent of total installed duct area for each designated pressure class.
e. Outdoor-Air Ducts with a Pressure Class of **2- (500)** Inch wg (Pa) or Higher: Test representative duct sections totaling no less than **50** percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
5. Test for leaks before applying external insulation.
6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
7. Give **seven** days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness in accordance with "Description of Method 3 - NADCA Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media is to not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.11 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. For cleaning of existing ductwork, see Section 230130.52 "Existing HVAC Air Distribution System Cleaning."

C. Use duct cleaning methodology as indicated in NADCA ACR.

D. Use service openings for entry and inspection.

1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

E. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

F. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

G. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

3.12 STARTUP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.13 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units

a. Pressure Class: Positive **2- (500)** inch wg (Pa).
b. Minimum SMACNA Seal Class: **B**.
c. SMACNA Leakage Class for Rectangular: **2**.
d. SMACNA Leakage Class for Round and Flat Oval: **2**.

2. Ducts Connected to Constant-Volume Air-Handling Units :

a. Pressure Class: Positive **2- (500)** inch wg (Pa).
b. Minimum SMACNA Seal Class: **B**.
c. SMACNA Leakage Class for Rectangular: **2**.
d. SMACNA Leakage Class for Round and Flat Oval: **2**.

3. Ducts Connected to Variable-Air-Volume Air-Handling Units :

a. Pressure Class: Positive **4- (1000)** inch wg (Pa).
b. Minimum SMACNA Seal Class: **A**.
c. SMACNA Leakage Class for Rectangular: **2**.
d. SMACNA Leakage Class for Round and Flat Oval: **2**.

4. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive **2- (500)** inch wg (Pa).
b. Minimum SMACNA Seal Class: **B**.
c. SMACNA Leakage Class for Rectangular: **2**.
d. SMACNA Leakage Class for Round and Flat Oval: **2**

C. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units :

a. Pressure Class: Positive or negative **2- (500)** inch wg (Pa).
b. Minimum SMACNA Seal Class: **B**.
c. SMACNA Leakage Class for Rectangular: **2**.
d. SMACNA Leakage Class for Round and Flat Oval: **2**.

2. Ducts Connected to Air-Handling Units :

a. Pressure Class: Positive or negative **3- (750)** inch wg (Pa).
b. Minimum SMACNA Seal Class: **B**.
c. SMACNA Leakage Class for Rectangular: **2**.

d. SMACNA Leakage Class for Round and Flat Oval: **2**.

3. Ducts Connected to Equipment Not Listed above:

a. Pressure Class: Positive or negative **2- (500)** inch wg (Pa).
b. Minimum SMACNA Seal Class: **B**.
c. SMACNA Leakage Class for Rectangular: **2**.
d. SMACNA Leakage Class for Round and Flat Oval: **2**.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

a. Pressure Class: Negative **2- (500)** inch wg (Pa).
b. Minimum SMACNA Seal Class: **B** if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: **2**.
d. SMACNA Leakage Class for Round and Flat Oval: **2**.

2. Ducts Connected to Dishwashers, Dishwasher Hoods, and Other High-Humidity Locations:

a. Type 304, stainless steel sheet.
b. Exposed to View: **No. 4** finish.
c. Concealed: **No. 2D** finish.
d. Welded longitudinal seams; welded or flanged transverse joints with watertight EPDM gaskets.
e. Pressure Class: Positive or negative **2- (500)** inch wg (Pa).
f. Airtight/watertight.

3. Ducts Connected to Fans Exhausting Welding Exhaust and Process (ASHRAE 62.1, Class 3 and Class 4) Air:

a. **Type 316**, stainless steel sheet.

1) Exposed to View: **No. 4** or **No. 3** finish.
2) Concealed: **No. 2B** or **No. 2D** finish.

b. PVC-coated, galvanized sheet steel with thicker coating on duct interior.
c. Pressure Class: Positive or negative **3- (750)**inch wg (Pa).
d. **Minimum SMACNA Seal Class A**. .
e. **SMACNA Leakage Class 2.**
f. **Airtight/watertight.**

4. Ducts Connected to Equipment Not Listed above:

a. Pressure Class: Positive or negative **2- (500)** inch wg (Pa).
b. Minimum SMACNA Seal Class: **B** if negative pressure; A if positive pressure.
c. SMACNA Leakage Class for Rectangular: **2**.
d. SMACNA Leakage Class for Round and Flat Oval: **2**.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units :

   a. Pressure Class: Positive or negative **2- (500)** inch wg (Pa).
   b. Minimum SMACNA Seal Class: **B**.
   c. SMACNA Leakage Class for Rectangular: 2.
   d. SMACNA Leakage Class for Round and Flat Oval: 2.

2. Ducts Connected to Air-Handling Units :

   a. Pressure Class: Positive or negative **2- (500)** inch wg (Pa).
   b. Minimum SMACNA Seal Class: **B**.
   c. SMACNA Leakage Class for Rectangular: **2**.
   d. SMACNA Leakage Class for Round and Flat Oval: **2**.

3. Ducts Connected to Equipment Not Listed Above:

   a. Pressure Class: Positive or negative **2- (500)** inch wg (Pa).
   b. Minimum SMACNA Seal Class: **B**.
   c. SMACNA Leakage Class for Rectangular: **2**.
   d. SMACNA Leakage Class for Round and Flat Oval: **2**.

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: **Galvanized steel or carbon steel coated with zinc-chromate primer**.
2. Stainless Steel Ducts:

   a. Exposed to Airstream: Match duct material.
   b. Not Exposed to Airstream: **Galvanized**.

G. Liner:
1. Return-Air Ducts: **Fibrous glass, Type I** or **Flexible elastomeric 1-1/2 (38)** inch (mm) thick.
2. Exhaust-Air Ducts: **Fibrous glass, Type I** or **Flexible elastomeric 1 (25)** inch (mm) thick.
3. Return- and Exhaust-Fan Plenums: **Fibrous glass, Type II** or **Flexible elastomeric 1 (25)** inches (mm) thick.
4. Transfer Ducts: **Fibrous glass, Type I** or **Flexible elastomeric 1 (25)** inch (mm) thick.

H. Elbow Configuration:

1. Rectangular Duct - Requirements for Different Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

   a. Velocity 1000 fpm (5 m/s) or Lower:

      1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      2) Mitered Type RE 4 without vanes.

   b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s):

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm (7.6 m/s) or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct Requirements for All Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm (5 m/s) or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm (5 to 7.6 m/s): 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm (7.6 m/s) or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, **12 (305)** Inches (mm) and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, **14 (356)** Inches (mm) and Larger in Diameter: **Standing seam**.

I. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.

b. Rectangular Main to Round Branch: Conical spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

   a. Velocity 1000 fpm (5 m/s) or Lower: 90-degree tap.
   b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap.
   c. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Control dampers.
4. Flange connectors.
5. Turning vanes.
6. Duct-mounted access doors.
7. Duct access panel assemblies.
8. Flexible connectors.
9. Duct accessory hardware.

B. Related Requirements:

1. Section 233346 "Flexible Ducts" for insulated and non-insulated flexible ducts.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop, dynamic insertion loss, and self-generated noise data. Include breakout noise calculations for high-transmission-loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Detail duct accessories' fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control-damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Duct security bars.
f. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, or BIM model, drawn to scale, and coordinated with each other, using input from installers of the items involved.

B. Source quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 90A and NFPA 90B.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Air Balance
   b. Airstream
   c. American Warming and Ventilation (AMV); Mestek, Inc.
   d. Arrow
   e. Cesco
   f. Flexmaster
   g. Greenheck Fan Corporation
   h. Honeywell
   i. Johnson Controls, Inc.
   j. National Controlled Air, Inc.
   k. Ruskin; Air Distribution Technologies, Inc
   l. Tamco
   m. Vent Products Co, Inc.

B. Description: Gravity balanced.

C. Performance:

   1. Maximum Air Velocity: **1250 fpm (6.4 m/s)**
   2. Maximum System Pressure: **2 inches wg (0.5 kPa)**.
   3. **AMCA Certification: Test and rate in accordance with AMCA 511.**

4. Leakage:

   a. Class IA: Leakage shall not exceed 3 cfm/sq. ft. (15.2 L/s per sq. m) against 1-inch wg (250-Pa) differential static pressure.
   b. Class I: Leakage shall not exceed 4 cfm/sq. ft. (20 L/s per sq. m) against 1-inch wg (250-Pa) differential static pressure.
   c. Class II: Leakage shall not exceed 10 cfm/sq. ft. (51 L/s per sq. m) against 1-inch wg (250-Pa) differential static pressure.
   d. Class III: Leakage shall not exceed 40 cfm/sq. ft. (203 L/s per sq. m) against 1-inch wg (250-Pa) differential static pressure.

D. Construction:

1. Frame:

   a. Hat shaped.
   b. **16-gauge- (1.6-mm-) thick, galvanized sheet steel** , with welded or mechanically attached corners **and mounting flange**.

2. Blades:

   a. Multiple single-piece blades.
   b. **Center or End** pivoted, maximum 6-inch (150-mm) width, **16-gauge- (1.6-mm-) thick, galvanized sheet steel** with sealed edges.

3. Blade Action: Parallel.

E. Blade Seals: **Neoprene, mechanically locked**.

F. Blade Axles:

1. Material: **Galvanized steel** or **Aluminum**.
2. Diameter: **0.20 inch (5 mm)**.

G. Tie Bars and Brackets: **Aluminum** or **Galvanized steel**.

H. Return Spring: Adjustable tension.

I. Bearings: **Steel ball or synthetic pivot bushings**.

J. Damper Actuator - Electric:

1. Electric - **120 V ac** or **24 V ac**.
2. UL 873 plenum rated.
3. **Two position** or **Fully modulating**.

   a. Sufficient motor torque to drive damper fully closed with adequate force to achieve required damper seal.
   b. Minimum 90-degree drive rotation.

4. Clockwise or counterclockwise drive rotation as required for application.

5. Environmental Operating Range:

   a. Temperature: Minus 40 to plus 130 deg F (Minus 40 to plus 55 deg C).
   b. Humidity: 5 to 95 percent relative humidity noncondensing.

6. Environmental Enclosure: NEMA 2.
7. Actuator to be factory mounted and provided with a single-point wiring connection.

K. Controllers, Electrical Devices, and Wiring:

1. Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
2. Electrical Connection: **115 V, single phase, 60 Hz** or **24 V, 60 Hz**.

L. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Chain pulls.
4. Screen Mounting:

   a. **Front** mounted in sleeve.

      1) Sleeve Thickness: 20 gauge (1.0 mm) minimum.
      2) Sleeve Length: 6 inches (150 mm) minimum.

5. Screen Material: **Galvanized steel**.
6. Screen Type: **Bird**.
7. 90-degree stops.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Air Balance
   b. Airstream
   c. American Warming and Ventilation (AMV); Mestek, Inc.
   d. Arrow
   e. Cesco
   f. Flexmaster
   g. Greenheck Fan Corporation
   h. Honeywell
   i. Johnson Controls, Inc.
   j. National Controlled Air, Inc.
   k. Ruskin; Air Distribution Technologies, Inc
   l. Tamco
   m. Vent Products Co, Inc.

2. Performance:

   a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. (203 L/s per sq. m) against 1-inch wg (250-Pa) differential static pressure.

3. Construction:

   a. Linkage out of airstream.
   b. Suitable for horizontal or vertical airflow applications.

4. Frames:

   a. Hat-shaped, **16-gauge- (1.6-mm-) thick, galvanized sheet steel**.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. **Galvanized** steel; 16 gauge (1.6 mm) thick.

6. Blade Axles: **Galvanized steel** or **Stainless steel**.
7. Bearings:

   a. **Oil-impregnated bronze** or **Molded synthetic**.
   b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.

8. Tie Bars and Brackets: Galvanized steel.
9. Locking device to hold damper blades in a fixed position without vibration.

2.4 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Air Balance
   b. Airstream
   c. American Warming and Ventilation (AMV); Mestek, Inc.
   d. Arrow
   e. Cesco
   f. Flexmaster
   g. Greenheck Fan Corporation
   h. Honeywell
   i. Johnson Controls, Inc.
   j. National Controlled Air, Inc.
   k. Ruskin; Air Distribution Technologies, Inc
   l. Tamco
   m. Vent Products Co, Inc.

B. General Requirements:

1. Unless otherwise indicated, use parallel-blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed-blade configuration.
2. Factory or field assemble multiple damper sections to provide a single damper assembly of size required by the application.

C. Performance:

1. **AMCA Certification: Test and rate in accordance with AMCA 511.**
2. Leakage:

   a. Class IA: Leakage shall not exceed 3 cfm/sq. ft. (15.2 L/s per sq. m) against 1-inch wg (250-Pa) differential static pressure.
   b. Class I: Leakage shall not exceed 4 cfm/sq. ft. (20 L/s per sq. m) against 1-inch wg (250-Pa) differential static pressure.
   c. Class II: Leakage shall not exceed 10 cfm/sq. ft. (51 L/s per sq. m) against 1-inch wg (250-Pa) differential static pressure.
   d. Class III: Leakage shall not exceed 40 cfm/sq. ft. (203 L/s per sq. m) against 1-inch wg (250-Pa) differential static pressure.

3. Pressure Drop: 0.05 inch wg (12.5 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested in accordance with AMCA 500-D, Figure 5.3.
4. Velocity: Up to **3000 fpm (15 m/s)**.
5. Temperature: Minus 25 to plus 180 deg F (Minus 32 to plus 83 deg C).
6. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

D. Construction:

1. Linkage out of airstream.
2. Suitable for horizontal or vertical airflow applications.
3. Frames:

   a. Hat, U, or angle shaped.
   b. **16-gauge- (1.6-mm-) thick, galvanized sheet steel**.
   c. **Mitered and welded** corners.
   d. Flanges for attaching to walls and flangeless frames for installing in ducts.

4. Blades:

   a. Multiple blade with maximum blade width of **6 inches (150 mm)**.
   b. **Parallel** or **Opposed**-blade design.
   c. **Galvanized steel** or **Stainless steel**.
   d. **16-gauge- (1.6-mm-) thick single skin**.

5. Blade Edging Seals:

   a. Replaceable **Closed-cell neoprene**.
   b. Inflatable seal blade edging, or replaceable rubber seals.

6. Blade Jamb Seal: Flexible stainless steel, compression type.
7. Blade Axles: 1/2-inch (13-mm) diameter; **galvanized** or **stainless** steel.
8. Blade-Linkage Hardware: Zinc-plated steel and brass; ends sealed against blade bearings. Linkage mounted out of air stream.
9. Bearings:

    a. **Oil-impregnated bronze** or **Molded synthetic**.
    b. Dampers mounted with vertical blades to have thrust bearings at each end of every blade.

E. Damper Actuator - Electric:

1. Electric - **120 V ac** or **24 V ac**.
2. UL 873, plenum rated.
3. **Two position** or **Fully modulating with fail-safe spring return**.

    a. Sufficient motor torqueto drive damper fully open and fully closed with adequate force to achieve required damper seal.
    b. Minimum 90-degree drive rotation.

4. Clockwise or counterclockwise drive rotation as required for application.
5. Environmental Operating Range:

    a. Temperature: Minus 40 to plus 130 deg F (Minus 40 to plus 55 deg C).
    b. Humidity: 5 to 95 percent relative humidity noncondensing.

6. Environmental enclosure: NEMA 2.
7. Actuator to be factory mounted and provided with a single-point wiring connection.

F. Controllers, Electrical Devices, and Wiring:

1. Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
2. Electrical Connection: **115 V, single phase, 60 Hz** or **24 V, 60 Hz**.

2.5 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Air Balance
    b. Airstream
    c. American Warming and Ventilation (AMV); Mestek, Inc.
    d. Arrow
    e. Cesco
    f. Flexmaster
    g. Greenheck Fan Corporation
    h. Honeywell
    i. Johnson Controls, Inc.
    j. National Controlled Air, Inc.
    k. Ruskin; Air Distribution Technologies, Inc

l. Tamco
m. Vent Products Co, Inc.

B. Description: **Add-on or roll-formed**, factory fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gauge and Shape: Match connecting ductwork.

2.6 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Air Balance
b. Airstream
c. American Warming and Ventilation (AMV); Mestek, Inc.
d. Arrow
e. Cesco
f. Flexmaster
g. Greenheck Fan Corporation
h. Honeywell
i. Johnson Controls, Inc.
j. National Controlled Air, Inc.
k. Ruskin; Air Distribution Technologies, Inc
l. Tamco
m. Vent Products Co, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Fabricate curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

E. Vane Construction:

1. **Single** or **Double** wall.
2. Single wall for ducts up to **48 inches (1200 mm)** wide and double wall for larger dimensions.

2.7 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Air Balance
   b. Airstream
   c. American Warming and Ventilation (AMV); Mestek, Inc.
   d. Arrow
   e. Cesco
   f. Flexmaster
   g. Greenheck Fan Corporation
   h. Honeywell
   i. Johnson Controls, Inc.
   j. National Controlled Air, Inc.
   k. Ruskin; Air Distribution Technologies, Inc
   l. Tamco
   m. Vent Products Co, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 7-2 (7-2M), "Duct Access Doors and Panels," and Figure 7-3, "Access Doors - Round Duct."

   1. Door:

      a. Double wall, rectangular.
      b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
      c. **24-gauge- (0.70-mm-) thick galvanized steel** door panel.
      d. Vision panel.
      e. Hinges and Latches: 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.
      f. Fabricate doors airtight and suitable for duct pressure class.

   2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

      a. 24-gauge- (0.70-mm-) thick galvanized steel or 0.032-inch- (0.81-mm-) thick aluminum frame.

   3. Number of Hinges and Locks:

      a. Access Doors Less Than 12 Inches (300 mm) Square: No hinges and two sash locks.
      b. Access Doors up to **18 Inches (460 mm)** Square: **Continuous** and two sash locks.
      c. Access Doors up to 24 by 48 Inches (600 by 1200 mm): **Continuous** and two compression latches **with outside and inside handles**.
      d. Access Doors Larger Than 24 by 48 Inches (600 by 1200 mm): **Continuous** and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:

   1. Door and Frame Material: Galvanized sheet steel.

a. **24-gauge- (0.70-mm-) thick galvanized steel** door panel.

2. Door: **Double wall with insulation fill** with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at **3.0 to 8.0 inches wg (800 to 2000 Pa)**.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: **1-inch- (25-mm-)** thick, fibrous-glass or polystyrene-foam board.

2.8 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Air Balance
   b. Airstream
   c. American Warming and Ventilation (AMV); Mestek, Inc.
   d. Arrow
   e. Cesco
   f. Flexmaster
   g. Greenheck Fan Corporation
   h. Honeywell
   i. Johnson Controls, Inc.
   j. National Controlled Air, Inc.
   k. Ruskin; Air Distribution Technologies, Inc
   l. Tamco
   m. Vent Products Co, Inc.

B. Fire-Performance Characteristics: Adhesives, sealants, fabric materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Materials: Flame-retardant or noncombustible fabrics.

E. Coatings and Adhesives: Comply with UL 181, Class 1.

F. Metal-Edged Connectors: Factory fabricated with a fabric strip **3-1/2 inches (89 mm)** wide attached to two strips of 2-3/4-inch- (70-mm-) wide, **0.028-inch- (0.7-mm-)** thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.

G. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.

1. Minimum Weight: **14 oz./sq. yd. (474 g/sq. m)**.
2. Tensile Strength: 450 lbf/inch (79 N/mm) in the warp and **340 lbf/inch (60 N/mm)** in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).

H. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of **1/4-inch (6-mm)** movement at start and stop.

2.9 DUCT ACCESSORY HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Air Balance
b. Airstream
c. American Warming and Ventilation (AMV); Mestek, Inc.
d. Arrow
e. Cesco
f. Flexmaster
g. Greenheck Fan Corporation
h. Honeywell
i. Johnson Controls, Inc.
j. National Controlled Air, Inc.
k. Ruskin; Air Distribution Technologies, Inc
l. Tamco
m. Vent Products Co, Inc.

B. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

C. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.10 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: **G90 (Z275)**.
2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a **No. 2** finish for concealed ducts and for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B209 (ASTM B209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B221 (ASTM B221M), Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless steel ducts.

F. Tie Rods: Galvanized steel, **1/4-inch (6-mm)** minimum diameter for lengths 36 inches (900 mm) or less; **3/8-inch (10-mm)** minimum diameter for lengths longer than 36 inches (900 mm).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.

C. Install **backdraft** or **control** dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Where multiple damper sections are necessary to achieve required dimensions, provide reinforcement to fully support damper assembly when fully closed at full system design static pressure.

E. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

F. Set dampers to fully open position before testing, adjusting, and balancing.

G. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.

H. Install fire **and smoke** dampers in accordance with UL listing.

I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum **50-ft. (15-m)** spacing.
8. Upstream from turning vanes.
9. For grease ducts, install at locations and spacing as required by NFPA 96.
10. Control devices requiring inspection.
11. Elsewhere as indicated.

J. Install access doors with swing against duct static pressure.

K. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
3. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
4. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).
5. Body Access: 25 by 14 inches (635 by 355 mm).
6. Body plus Ladder Access: 25 by 17 inches (635 by 430 mm).

L. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

M. Install flexible connectors to connect ducts to equipment.

N. For fans developing static pressures of 5 inches wg (1250 Pa) and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

O. Install duct test holes where required for testing and balancing purposes.

P. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch (6-mm) movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.

2. Inspect locations of access doors, and verify that size and location of access doors are adequate to perform required operation.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation, and verify that vanes do not move or rattle.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 233346 - FLEXIBLE DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Flexible ducts, insulated.
   2. Flexible duct connectors.

1.2 ACTION SUBMITTALS

A. Product data.

B. Product Data Submittals: For each type of product.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A and NFPA 90B.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials must be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. Comply with the Air Duct Council's (formerly, Air Diffusion Council) "ADC Flexible Air Duct Test Code - FD 72-R1" and "Flexible Duct Performance & Installation Standards."

D. Comply with ASTM E96/E96M.

2.2 FLEXIBLE DUCTS, INSULATED

A. Standard: Product is to be UL 181 listed and bearing the UL label. Shall not exceed 25 Flame Spread and 50 Smoke Developed.

B. Flexible Ducts, Insulated - Class 1, Two-Ply Vinyl Film Supported by Helically Wound, Spring-Steel Wire; Fibrous-Glass Insulation:

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Flexmaster U.S.A., Inc. Type 3M or TL V

2. Pressure Rating: 10 inch wg (2500 Pa) positive and 1.0 inch wg (250 Pa) negative.
3. Maximum Air Velocity: 4000 fpm (20 m/s).
4. Temperature Range: Minus 10 to plus 160 deg F (Minus 23 to plus 71 deg C).
5. Insulation R-Value: **Comply with ASHRAE/IES 90.1**.
6. Vapor-Barrier Film: **Polyethylene** or **Aluminized**.

C. Flexible Ducts, Insulated - Class 1, Multiple Layers of Aluminum Laminate Supported by Helically Wound, Spring-Steel Wire; Fibrous-Glass Insulation:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Flexmaster U.S.A., Inc. Type 3M

2. Pressure Rating: 10 inch wg (2500 Pa) positive and 1.0 inch wg (250 Pa) negative.
3. Maximum Air Velocity: 4000 fpm (20 m/s).
4. Temperature Range: Minus 20 to plus 210 deg F (Minus 29 to plus 99 deg C).
5. Insulation R-Value: **Comply with ASHRAE/IES 90.1**.
6. Vapor-Barrier Film: **Polyethylene** or **Aluminized**.

D. Option to insulated rigid round ductwork:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flexmaster Type TL-V.

2. Pre-insulated, semi-rigid, triple-lock, aluminum, flexible, round ductwork for branch runouts and connections to diffusers.
3. Maximum Air Velocity: 4000 fpm (20 m/s).
4. Temperature Range: Minus 20 to plus 210 deg F (Minus 29 to plus 99 deg C).
5. Insulation R-Value: **Comply with ASHRAE/IES 90.1**.
6. Pressure Rating: 6 inch wg positive at 4.0 inch wg negative.

2.3 FLEXIBLE DUCT CONNECTORS

A. Clamps: **Stainless steel band with stainless steel or zinc-plated hex screw to tighten band with a worm-gear action** or **Nylon strap** in sizes 3 through 18 inches (75 through 460 mm), to suit duct size.

B. Flexible Duct Connections Option: Ventfabrics “Ventglas.” 30 oz. neoprene-coated glass fabric.

2.4 ADHESIVES

A. Adhesives shall have a VOC content of 50g/L or less.

PART 3 - EXECUTION

3.1 INSTALLATION OF FLEXIBLE DUCTS

A. Install flexible ducts in accordance with applicable details in the following publications:

1. ADC's "Flexible Duct Performance & Installation Standards" for flexible ducts.
2. NAIMA AH116.
3. SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.
4. SMACNA's "Fibrous Glass Duct Construction Standards" for fibrous-glass ducts.

B. Install in indoor applications only. Do not install flexible duct in locations where it will be exposed to UV lighting.

C. Connect diffusers ducts **directly** with maximum **60-inch (1500-mm)** lengths of flexible duct clamped or strapped in place.

D. Connect flexible ducts to metal ducts with **draw bands** and **adhesive plus sheet metal screws**.

E. Install duct test holes where required for testing and balancing purposes.

F. Installation:

1. Install ducts fully extended.
2. Do not bend ducts across sharp corners.
3. Bends of flexible ducting must not exceed a minimum of one-duct diameter.
4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
5. Install flexible ducts in a direct line, without sags, twists, or turns.
6. Install in accordance with ADC instructions.

G. Supporting Flexible Ducts:

1. Support flexible duct at manufacturer's recommended intervals, but at no greater distance than 4 ft. (1.2 m). Provide sufficient support so that maximum centerline sag is 1/2 in. per ft. (42 mm per meter) between supports. A connection to rigid duct or equipment may be considered a support joint.
2. Install extra supports at bends placed approximately one-duct diameter from center line of the bend.
3. Ducts may rest on ceiling joists or truss supports. Spacing between supports must not exceed the maximum spacing in accordance with manufacturer's written installation instructions.
4. Vertically installed ducts must be stabilized by support straps at a maximum of 72 inches (1800 mm) o.c.

END OF SECTION 233346

SECTION 233400 - HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Fans, centrifugal, inline - square.
2. Ventilators, centrifugal - ceiling mounted.
3. Ventilators, centrifugal - sidewall mounted.
4. Fans, propeller - sidewall mounted.

1.2 ACTION SUBMITTALS

A. Product data.

B. Shop Drawings:

1. Plans, elevations, sections, and attachment details.
2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Diagrams for power, signal, and control wiring.
4. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittal: For vibration isolation**, supports,** indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting vibration isolators**, supports, and for designing vibration isolation bases**.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans showing fan rooms and fan system layouts, reflected ceiling plans, and other drawings required to illustrate relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

B. Startup service reports.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1. Operation in normal and emergency modes.
2. Operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation**, supports**, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

F. Capacities and Characteristics:
1. Refer to mechanical schedules on drawings.

G. Service Conditions:
1. Refert to mechanical drawings.

2.2 FANS, CENTRIFUGAL, INLINE - SQUARE

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
a. Carnes
b. Jenn Fan
c. Loren Cook Company
d. PennBarry Fan Co.
e. Greenheck

B. Description: Square-housing in-line centrifugal fans.

C. Standards: Comply with UL 705.

D. Housing:

1. Housing Material: Galvanized steel.
2. Housing Coating: **Powder-baked enamel**.
3. Housing Construction: Side panels are to be easily removable for service. Include inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

E. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

F. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosures around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

G. Fan Wheels: Aluminum airfoil blades welded to aluminum hub.

H. Motor Enclosure: **Open, dripproof**.

I. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
3. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
4. Companion Flanges: For inlet and outlet duct connections.
5. Fan Guards: 1/2- by 1-inch (13- by 25-mm) mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
6. Motor: Epoxy-coated steel.
7. Belt Guards: Fabricate of prime-coated steel to comply with OSHA and SMACNA requirements for motors with exposed drive belt. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
8. Side Discharge: Flange connector and attachment hardware to provide right-angle discharge on side of unit.

2.3 VENTILATORS, CENTRIFUGAL - CEILING MOUNTED

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
   a. Carnes
   b. Jenn Fan
   c. Loren Cook Company
   d. PennBarry Fan Co.
   e. Greenheck

B. Standards: Comply with UL 705.

C. Housing: Steel, lined with acoustical insulation.

D. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel are removable for service.

E. Back-draft damper: Integral.

F. Grille: **Plastic**, white, louvered grille with flange on intake and thumbscrew or spring retainer attachment to fan housing.

G. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

H. Accessories:

1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
4. Motion Sensor: Motion detector with adjustable shutoff timer.
5. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless steel springs, and fusible link.
6. Filter: Washable aluminum to fit between fan and grille.
7. Isolation: Rubber-in-shear vibration isolators.
8. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.4 VENTILATORS, CENTRIFUGAL - SIDEWALL MOUNTED

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
   a. Carnes
   b. Jenn Fan
   c. Loren Cook Company
   d. PennBarry Fan Co.
   e. Greenheck

B. Standards:

1. Comply with UL 705.
2. Power ventilators for use with restaurant kitchen exhaust are to comply with UL 762.

C. Configuration: Centrifugal **sidewall** ventilator.

D. Housing: Removable **spun aluminum**; square, one-piece aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.

E. Fan Wheels: Aluminum hub and wheel with backward-inclined blades .

F. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings; minimum ABMA 9, **L10 of 100,000 hours**.
4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through **5** hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than **5** hp.
6. Fan and motor are isolated from exhaust airstream.

G. Accessories:

1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted **outside** fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
6. Mounting Pedestal: Galvanized steel with removable access panel.
7. Wall Mount Adapter: Attach wall-mounted fan to wall.

2.5 FANS, PROPELLER - SIDEWALL MOUNTED

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
   a. Loren Cook Company
   b. PennBarry Fan Co.
   c. Greenheck

B. Standards: Comply with UL 705.

C. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring, with baked-enamel finish coat applied after assembly.

D. Fan Wheels: Formed-steel blades riveted to heavy-gauge steel spider bolted to cast-iron hub.

E. Fan Wheel: Replaceable, **cast**-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

F. Fan Drive, Direct: Direct-drive motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

G. Fan Drive, Belt:

1. Belt drive.
2. Resiliently mounted to housing.
3. Statically and dynamically balanced.

4. Selected for continuous operation at maximum-rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
5. Extend grease fitting to accessible location outside of unit.
6. Service Factor Based on Fan Motor Size: 1.4.
7. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
8. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

    a. Ball-Bearing Rating Life: ABMA 9, **L10 of 100,000 hours**.

9. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
10. Motor Pulleys: Adjustable pitch for use with motors through **5** hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
11. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

H. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
2. Dampers: Counterbalanced, parallel-blade, backdraft dampers factory set to close when fan stops.
3. Motorized Dampers: Parallel-blade dampers with electric actuator wired to close when fan stops.
4. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
5. Wall Sleeve: Galvanized steel to match fan and accessory size.
6. Weathershield Hood: Galvanized steel to match fan and accessory size.
7. Weathershield Front Guard: Galvanized steel with expanded metal screen.
8. Belt Guard: For motor mounted on outside of fan cabinet. Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; **0.146-inch- (2.7-mm-)** thick, **3/4-inch (20-mm)** diamond-mesh wire screen, welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

2.6 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

B. Where variable-frequency drives are indicated or scheduled, provide fan motor compatible with variable-frequency drive.

2.7 SOURCE QUALITY CONTROL

A. **AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311.**

B. **AMCA Certification for Fan Aerodynamic Performance Ratings: Test, rate, and label in accordance with AMCA 211.**

C. **AMCA Certification for Fan Energy Index (FEI): Test, rate, and label in accordance with AMCA 211.**

D. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install fans level and plumb.

B. Disassemble and reassemble units, as required for moving to the final location, in accordance with manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting:

1. Install floor-mounted fans on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Unit Support: Install fans level on structural curbs. Coordinate with duct connections. **Coordinate wall penetrations and flashing with wall construction. Secure units to structural support with anchor bolts.**
3. Support duct-mounted and other hanging fans directly from the building structure, using suitable hanging systems as specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
4. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Curb Support, Prefabricated: Rail-type wood support provided by fan manufacturer.

F. Unit Support: Install centrifugal fans level on structural **curbs**. Coordinate with duct connections. **Coordinate wall penetrations and flashing with wall construction. Secure units to structural support with anchor bolts.**

G. Isolation Curb Support: Install centrifugal fans on isolation curbs, and install flexible duct connectors and vibration-isolation devices.
1. Comply with requirements in Section 230548.13 "Vibration Controls for HVAC."

H. Install units with adequate clearances for service and maintenance.

I. Label fans in accordance with requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Where installing ducts adjacent to fans, allow space for service and maintenance.

3.3 PIPING CONNECTIONS

A. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

B. Install heat tracing on all drain piping subject to freezing temperature and as indicated on Drawings. Furnish and install heat tracing in accordance with Section 230533 "Heat Tracing for HVAC Piping."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.6 STARTUP SERVICE:

A. **Perform** startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
6. For belt-drive fans, disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
7. Adjust belt tension.
8. Adjust damper linkages for proper damper operation.
9. Verify lubrication for bearings and other moving parts.
10. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
11. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
12. Shut unit down and reconnect automatic temperature-control operators.
13. Remove and replace malfunctioning units and retest as specified above.

3.7 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.8 CLEANING

A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: **Contractor** will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties.
3. Fans and components will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. **Train** Owner's maintenance personnel to adjust, operate, and maintain HVAC fans.

END OF SECTION 233400

SECTION 233713.13 - AIR DIFFUSERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ceiling diffusers - rectangular and square face.

B. Related Requirements:

   1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers.
   2. Section 233713.23 "Air Registers and Grilles" for adjustable-bar register and grilles, fixed-face registers and grilles, and linear bar grilles.

1.2 ACTION SUBMITTALS

A. Product data.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

   1. Ceiling suspension assembly members.
   2. Method of attaching hangers to building structure.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
   5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS - SQUARE FACE

A. Ceiling Diffuser - Square :

   1. Manufacturers: Subject to compliance with requirements, **provide products by one of the following**:

      a. A-J Manufacturing Co., Inc.
      b. Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.

c. Carnes Company.
d. Hart & Cooley, LLC.
e. Kees, Inc.
f. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
g. METALAIRE, Inc.
h. Price Industries Limited.
i. Raymon Company.
j. Shoemaker Mfg. Co.
k. Titus; brand of Johnson Controls International plc, Global Products.
l. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.

2. Description: **Square** ceiling diffuser with round or rectangular duct collar and a series of curved louvers to provide discharge parallel to ceiling surface.
3. Source Limitations: Obtain from single source from single manufacturer.
4. Material: **Steel**.
5. Finish: **Baked enamel, white**.
6. Face Size: **24 by 24 inches (600 by 600 mm)** or **12 by 12 inches (300 by 300 mm)**.
7. Face Style: **Three cone**.
8. Mounting: **Surface**, **T-bar, or Mounting panel**.
9. Pattern: **Adjustable**.
10. Dampers: **Radial opposed blade**, heavy-gauge, steel control.
11. Accessories:

a. Equalizing grid.
b. Plaster ring.
c. Safety chain.
d. Wire guard.
e. Sectorizing baffles.

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers in accordance with ASHRAE 70.

PART 3 - EXECUTION

3.1 INSTALLATION OF AIR DIFFUSERS

A. Install diffusers level and plumb.

B. Ceiling-Mounted Outlets and Inlets: For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.13

SECTION 233713.23 - REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Grilles - fixed-blade face.

B. Related Requirements:

   1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to registers and grilles.
   2. Section 233713.13 "Air Diffusers" for various types of air diffusers.

1.2 ACTION SUBMITTALS

A. Product data.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

   1. Ceiling suspension assembly members.
   2. Method of attaching hangers to building structure.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
   5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 GRILLES

A. Grilles – Fixed-Blade Face, Eggcrate Type (EG- and RG-):

   1. Manufacturers: Subject to compliance with requirements, **provide products by one of the following**:

      a. A-J Manufacturing Co., Inc.
      b. Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.
      c. Carnes Company.

d. Dayus Register & Grille Inc.
e. Hart & Cooley, LLC.
f. Kees, Inc.
g. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
h. METALAIRE, Inc.
i. Price Industries Limited.
j. Raymon Company.
k. Shoemaker Mfg. Co.
l. Titus; brand of Johnson Controls International plc, Global Products.
m. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.

2. Material: **Aluminum**.
3. Finish: **Baked enamel, white.**
4. Face-Blade Arrangement: Fixed-face blade position, ½" x ½" x ½" egg-crated aluminum grid.
5. Frame: **1-1/4 inches (32 mm)** wide. Heavy extruded aluminum with thickness of 0.040-0.050 inch.
6. Mounting: **Lay in**.
7. Free Area: Minimum 90%.

B. Grilles - Fixed-Blade Face, 35 Deg Deflection (TG-):

1. Manufacturers: Subject to compliance with requirements, **provide products by one of the following**:

a. A-J Manufacturing Co., Inc.
b. Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.
c. Carnes Company.
d. Dayus Register & Grille Inc.
e. Hart & Cooley, LLC.
f. Kees, Inc.
g. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
h. METALAIRE, Inc.
i. Price Industries Limited.
j. Raymon Company.
k. Shoemaker Mfg. Co.
l. Titus; brand of Johnson Controls International plc, Global Products.
m. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.

2. Material: **Stainless Steel**.
3. Finish: **Baked enamel, white.**
4. Face-Blade Arrangement: Fixed-face blade position, horizontally spaced 3/4 inch (19 mm) apart, 35 deg blade deflection angle.
5. Frame: **1-1/4 inches (32 mm)** wide. Stainless steel. Countersunk screw holes.
6. Mounting: As shown on drawings.
7. Free Area: Minimum 90%.
8. Damper: Opposed-blade, heavy gauge, steel control.

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate registers and grilles in accordance with ASHRAE 70.

PART 3 - EXECUTION

3.1 INSTALLATION OF REGISTERS AND GRILLES

A. Install registers and grilles level and plumb.

B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.23

SECTION 235113.11 - DRAFT CONTROL FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Draft inducer fans.

B. Related Requirements:

1. Section 235113.16 "Vent Dampers" for barometric dampers and vent dampers.
2. Section 235123 "Gas Vents" for Type B and BW vents, Type L vents, and listed special gas vents.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For each type of product.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of hangers and seismic restraints.
4. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of **draft inducer fans** that fail in materials or workmanship within specified warranty period.

1. Warranty Period: **Two** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 DRAFT INDUCER FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Barry Blower
   2. Buffalo Forge
   3. Combustion Equipment
   4. Tjernlund Products, Inc.
   5. Wing Draft Inducers.

B. Fan Construction: **Galvanized**-steel housing and radial-blade centrifugal fan.
   1. Fan Motor: Permanent-split-capacitor type.
   2. Counter clockwise fan rotation with bottom horizontal discharge.

C. Controls:

   1. Draft-proving switch.
   2. Control kit to cycle fan with gas flow to a single burner.
   3. Universal interlock electrical burner circuit interlock.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

B. Provide open drop-proof type motor.

2.3 CAPACITIES AND CHARACTERISTICS

A. Refer to mechanical drawings.

B. Verify that the fan will be suitable for the application which it is used.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install listed components in a manner complying with the listing.

B. Install draft inducer fans in single-wall vent section that is designed to couple with other vent materials.

C. Secure draft inducer fans to appliances, breechings, or stacks with hardware compatible with connected materials.

D. Install draft inducer fans with clearances for service and maintenance.

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 235113.11

SECTION 235113.16 - VENT DAMPERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Barometric dampers.
2. Vent dampers.

B. Related Requirements:

1. Section 235113.11 "Draft Control Fans" for draft inducer fans, venturi-draft inducer fans, mechanical-draft vent fans, vent exhaust fans, and combustion-air fans.
2. Section 235123 "Gas Vents" for Type B and BW vents, Type L vents, and listed special gas vents.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For each type of product.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of hangers and seismic restraints.
4. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of **barometric dampers** and **vent dampers** that fail in materials or workmanship within specified warranty period.

1. Warranty Period: **Two** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 BAROMETRIC DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ENERVEX Inc.
2. Effikal International Inc.
3. FAMCO.
4. Field Controls L.L.C.
5. Quickdraft.
6. Snappy Air Distribution Products.
7. Tec-Air Inc.
8. Tjernlund Products, Inc.

B. Damper Construction: High-temperature-enamel-painted steel damper and housing with galvanized-steel breeching connection. Adjustable counterweight with lock. Include knife-edge bearings that do not require lubrication.

2.2 VENT DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Effikal International Inc.
2. Field Controls L.L.C.
3. Johnson Controls, Inc.

B. Damper Construction: Stainless steel damper blade, shaft, and vent pipe with metal, prelubricated bearings.

1. Electric motor sized to power damper open and closed in approximately 15 seconds in each direction. Power is off when damper is at rest.
2. Comply with ANSI Z21.66.

C. Controls:

1. Control transformer.
2. Keyed wiring harness.
3. Damper end switch to prove damper is open.
4. Interlock with boiler to permit burner operation when damper is open.
5. Hold-open switch for troubleshooting boiler controls.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

2.4 CAPACITIES AND CHARACTERISTICS

A. Damper:

1. Refer to mechanical drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install listed components in a manner complying with the listing.

B. Secure barometric dampers to breechings with hardware compatible with connected materials.

C. Locate barometric and motorized vent dampers as close to draft hood collar as possible.

D. Secure barometric and motorized vent dampers to appliances, breechings, or chimneys with hardware compatible with connected materials.

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 235113.16

SECTION 235116 - FABRICATED BREECHINGS AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Field-fabricated metal breechings.
2. Guying and bracing materials.

B. Related Requirements:

1. Section 235113.11 "Draft Control Fans" for draft inducer fans, venturi-draft inducer fans, mechanical-draft vent fans, vent exhaust fans, and combustion-air fans.
2. Section 235113.16 "Vent Dampers" for motorized and barometric dampers.
3. Section 235123 "Gas Vents" for Type B and BW vents, Type L vents, and listed special gas vents.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For breechings.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of hangers and seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Sample Warranty: For special warranty.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in breechings.

B. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

PART 2 - PRODUCTS

2.1 FIELD-FABRICATED METAL BREECHINGS

A. Fabricate breechings from ASTM A1011/A1011M hot-rolled steel with continuously welded joints, complying with NFPA 211 for minimum metal thickness.

1. Equal to or Less Than 1.069 Sq. Ft. (0.099 Sq. m.) or 14 Inches (356 mm) in Diameter: 0.053 inch (1.35 mm).
2. Up to 1.396 Sq. Ft. (0.129 Sq. m) or 16 Inches (406 mm) in Diameter: 0.067 inch (1.7 mm).
3. Up to 1.764 Sq. Ft. (0.164 Sq. m.) or 18 Inches (457 mm) in Diameter: 0.093 inch (2.36 mm).
4. Larger Than 1.764 Sq. Ft. (0.164 Sq. m.) or 18 Inches (457 mm) in Diameter: 0.123 inch (3.12 mm).

B. Fabricate cleanout doors from compatible material, same thickness as breeching, bolted and gasketed.

2.2 GUYING AND BRACING MATERIALS

A. Cable: **Four** galvanized, stranded wires of the following thickness:

1. Minimum Size: 1/4 inch (6 mm) in diameter.
2. For ID Sizes 4 to 15 Inches (100 to 381 mm): 5/16 inch (8 mm).
3. For ID Sizes 18 to 24 Inches (457 to 610 mm): 3/8 inch (9.5 mm).
4. For ID Sizes 27 to 30 Inches (685 to 762 mm): 7/16 inch (11 mm).
5. For ID Sizes 33 to 36 Inches (838 to 915 mm): 1/2 inch (13 mm).
6. For ID Sizes 39 to 48 Inches (990 to 1220 mm): 9/16 inch (14.3 mm).
7. For ID Sizes 51 to 60 Inches (1295 to 1524 mm): 5/8 inch (16 mm).

B. Pipe: **Three** galvanized steel, NPS 1-1/4 (DN 32).

C. Angle Iron: **Three** galvanized steel, 2 by 2 by 0.25 inch (50 by 50 by 6 mm).

PART 3 - EXECUTION

3.1 INSTALLATION OF UNLISTED, FIELD-FABRICATED BREECHINGS

A. Install breechings on dual-fuel boilers, oven vents, water heaters, fireplaces, and other solid-fuel-burning appliances.

B. Suspend breechings independent of their appliance connections.

C. Align breechings at connections, with smooth internal surface and a maximum 1/8-inch (3-mm) misalignment tolerance.

D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.

E. Lap joints in direction of flow.

F. Support breechings from building structure with bolts, concrete inserts, steel expansion anchors, welded studs, C clamps, or beam clamps.

G. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.

H. After completing system installation, remove burrs, dirt, and construction debris, and repair damaged finishes.

I. Provide temporary closures at ends of breechings that are not completed or connected to equipment.

END OF SECTION 235116

SECTION 235123 - GAS VENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Listed double-wall vents.

B. Related Requirements:

1. Section 235113.11 "Draft Control Fans" for draft inducer fans, venturi-draft inducer fans, mechanical-draft vent fans, vent exhaust fans, and combustion-air fans.
2. Section 235113.16 "Vent Dampers" for motorized and barometric dampers.
3. Section 235116 "Fabricated Breechings and Accessories" for listed, refractory-lined metal breechings and field-fabricated metal breechings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For vents.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of hangers and seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Sample Warranty: For special warranty.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents.

B. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

PART 2 - PRODUCTS

2.1 LISTED TYPE B (FOR PRESSURE WASHER AND INFRARED RADIANT HEATERS) AND BW VENTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amerivent
2. AMPCO
3. DuraVent.
4. Metal-Fab, Inc.
5. Schebler Co.
6. Van-Packer

B. Description: Double-wall metal vents tested according to UL 441 and rated for 480 deg F (248 deg C) continuously for Type B or 550 deg F (288 deg C) continuously for Type BW; with neutral or negative flue pressure complying with NFPA 211.

C. Construction: Inner shell and outer jacket separated by at least a 1/4-inch (6-mm) airspace.

D. Inner Shell: **ASTM B209 (ASTM B209M), Type 3105 aluminum**.

E. Outer Jacket: **Galvanized** steel.

F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination: Stack cap designed to exclude minimum 90 percent of rainfall.
2. Termination: Round chimney top designed to exclude minimum 98 percent of rainfall.
3. Termination: Exit cone with drain section incorporated into riser.
4. Termination: Antibackdraft.

2.2 LISTED TYPE L VENTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amerivent
2. AMPCO
3. DuraVent.
4. Metal-Fab, Inc.
5. Schebler Co.
6. Van-Packer

B. Description: Double-wall metal vents tested according to UL 641 and rated for 570 deg F (300 deg C) continuously or 1700 deg F (926 deg C) for 10 minutes; with neutral or negative flue pressure complying with NFPA 211.

C. Construction: Inner shell and outer jacket separated by at least a **1/4-inch (6-mm)** airspace filled with high-temperature, **mineral-wool** insulation.

D. Inner Shell: ASTM A666, **Type 304** stainless steel.

E. Outer Jacket: **Galvanized** steel.

F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination: Stack cap designed to exclude 90 percent of rainfall.
2. Termination: Round chimney top designed to exclude 98 percent of rainfall.
3. Termination: Exit cone with drain section incorporated into riser.

2.3 LISTED SPECIAL GAS VENTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amerivent
2. AMPCO
3. DuraVent.
4. Metal-Fab, Inc.
5. Schebler Co.
6. Van-Packer

B. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 deg F (248 deg C) continuously, with positive or negative flue pressure complying with NFPA 211.

C. Construction: Inner shell and outer jacket separated by at least a 1/2-inch (13-mm) airspace.

D. Inner Shell: ASTM A959, Type 29-4C stainless steel.

E. Outer Jacket: **Aluminized** steel.

F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination: Stack cap designed to exclude minimum 90 percent of rainfall.
2. Termination: Round chimney top designed to exclude minimum 98 percent of rainfall.
3. Termination: Exit cone with drain section incorporated into riser.

2.4 PVC VENTS (FURNACES)

A. Schedule 40 PVC, 5 inch, as recommended by the manufacturer. Pitch all horizontal runs upward from equipment at a minimum of 1/4 inch per foot.

PART 3 - EXECUTION

3.1 APPLICATION

A. Listed Type B and BW Vents: Vents for certified gas appliances.

B. Listed Type L Vent: Vents for low-heat appliances.

C. Listed Special Gas Vent: Condensing gas appliances.

3.2 INSTALLATION OF LISTED VENTS

A. Comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.

B. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer.

C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

D. Lap joints in direction of flow.

E. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

END OF SECTION 235123

SECTION 235416.13 - GAS-FIRED FURNACES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Gas-fired furnaces, condensing.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

   1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace the following components of furnaces that fail in materials or workmanship within specified warranty period:

   1. Warranty Period, Commencing on Date of Substantial Completion:

      a. Furnace Heat Exchanger: **10 years**.
      b. Integrated Ignition and Blower Control Circuit Board: **Five years**.
      c. Draft-Inducer Motor: **Five years**.
      d. <**Insert components requiring extended warranty**>.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a qualified testing agency, and marked for intended location and application.

B. General Requirements for Noncondensing Gas-Fired Furnaces: Factory assembled, piped, wired, and tested; complying with ANSI Z21.47/CSA 2.3 and NFPA 54.

2.2 GAS-FIRED FURNACES, CONDENSING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bryant; Carrier Global Corporation.
2. Carrier Global Corporation.
3. Lennox.
4. Trane.

B. Cabinet: **Steel** or **Galvanized steel**

1. Cabinet interior around heat exchanger shall be factory-installed insulation.
2. Lift-out panels shall expose burners and all other items requiring access for maintenance.
3. Factory paint external cabinets in manufacturer's standard color.
4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Fan: Centrifugal, factory balanced, resilient mounted, direct drive.

1. Fan Motors: Comply with requirements in Section 230500 "Common Work Results for HVAC."
2. Special Motor Features, Single Speed: Single speed, premium efficiency, as defined in Section 230500 "Common Work Results for HVAC," and with internal thermal protection and permanent lubrication.
3. Special Motor Features, Multispeed: Multitapped, multispeed with internal thermal protection and permanent lubrication.
4. Special Motor Features, ECM: Electronically controlled motor (ECM) controlled by integrated furnace/blower control.

D. Type of Gas: **Natural**.

E. Heat Exchanger:

1. Primary: **Aluminized** steel.
2. Secondary: **Stainless** steel.

F. Burner:

1. Gas Valve: 100 percent safety **two-stage** main gas valve, main shutoff valve, pressure regulator, safety pilot with electronic flame sensor, limit control, transformer, and combination ignition/fan timer control board.
2. Ignition: Electric pilot ignition, with hot-surface igniter or electric spark ignition.

G. Gas-Burner Safety Controls:

1. Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.

2. Flame Rollout Switch: Installed on burner box; prevents burner operation.
3. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.

H. Combustion-Air Inducer: Centrifugal fan with thermally protected motor and sleeve bearings prepurges heat exchanger and vents combustion products; pressure switch prevents furnace operation if combustion-air inlet or flue outlet is blocked.

I. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; adjustable fan-on and fan-off timing; terminals for connection to accessories.

J. Accessories:

1. Combination Combustion-Air Intake and Vent: PVC plastic fitting to combine combustion-air inlet and vent through **outside wall** or **roof**.
2. CPVC Plastic Vent Materials:

a. CPVC Plastic Pipe: Schedule 40, complying with ASTM F441/F441M.
b. CPVC Plastic Fittings: Schedule 40, complying with ASTM F438, socket type.
c. CPVC Solvent Cement: ASTM F493.

3. PVC Plastic Vent Materials:

a. PVC Plastic Pipe: Schedule 40, complying with ASTM D1785.
b. PVC Plastic Fittings: Schedule 40, complying with ASTM D2466, socket type.
c. PVC Solvent Cement: ASTM D2564.

K. Capacities and Characteristics:

1. Refer to mechanical schedules on drawings.

2.3 THERMOSTATS AND HUMIDISTATS

A. Controls shall comply with requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."

B. Solid-State Thermostat: **Wall-mounted**, programmable, microprocessor-based unit with **automatic** switching from heating to cooling, preferential rate control, seven-day programmability with minimum of four temperature presets per day, and battery backup protection against power failure for program settings.

C. Single-Stage, Heating-Cooling Thermostat: Adjustable, heating-cooling, wall-mounted unit with fan on-automatic selector.

D. Two-Stage, Heating-Cooling Thermostat: Adjustable, heating-cooling, wall-mounted unit with fan on-automatic selector.

E. Control Wiring: Balanced twisted-pair cabling complying with requirements for Category 5e in **Section 260523 "Control-Voltage Electrical Power Cables."**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. AMP NETCONNECT; a TE Connectivity Ltd. company.
    b. Belden Inc.
    c. Berk-Tek, a Leviton Company.
    d. CommScope, Inc.
    e. General Cable; Prysmian Group North America.
    f. Hitachi Cable America Inc.
    g. Mohawk; a division of Belden Networking, Inc.
    h. West Penn Wire; brand of Belden, Inc.

2. Description: **Shielded twisted pairs (FTP)** , No. 24 AWG, 100 ohms, four pair.
3. Cable Jacket Color: **Blue**.

2.4 AIR FILTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aprilaire; Research Products Corp.
2. Filtrete Home Filtration Products; a 3M brand.
3. General Filters, Inc.
4. Permatron Corporation.

B. Disposable Filters: **1-inch- (25-mm-)**thick fiberglass media **with ASHRAE 52.2 MERV rating of 8 or higher,** in sheet metal frame.

C. Charged Media Air Filters: Sheet metal housing arranged to be ducted in return-air duct connection to furnace; generates electrostatic charge; MERV 10 rating.

D. HEPA Air Filter Units: Sheet metal housing with fan arranged to be ducted to return-air duct connection to furnace, with activated carbon prefilter**,** and high-efficiency particulate air (HEPA) disposable filter. HEPA shall be as follows:

1. Standard: UL 586.
2. Rating: ASHRAE 52.2, 99.97 percent efficiency to 0.30-micrometer particle size.

2.5 HUMIDIFIERS

A. Minimum capacity rating indicated according to AHRI 610.

B. Media-wheel bypass type with bypass damper and motor-driven media wheel in reservoir with float-valve level control; arranged for mounting on return duct or plenum with bypass connection to supply duct.

C. Wetted-pad, continuous-drain, bypass type with bypass damper and water-flow control orifice; arranged for mounting on return duct or plenum with bypass connection to supply duct.

D. Fan-powered, wetted-pad, continuous-drain type with water-flow control orifice and motor; arranged for mounting on duct or plenum.

E. Pumped, fan-powered, wetted-pad type with reservoir-level control and pump and fan motors; arranged for mounting on duct or plenum.

F. Comply with applicable requirements in ASHRAE 62.1.

G. Capacities and Characteristics:
   1. Refer to mechanical schedules on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install gas-fired furnaces and associated fuel and vent features and systems according to NFPA 54.

B. Suspended Units: Suspend from structure using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

C. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base if required by installation conditions.

D. Controls: Install thermostats and humidistats at mounting height of 60 inches (1500 mm) above floor.

E. Wiring Method: Install control wiring in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal control wiring except in unfinished spaces.

3.2 PIPING CONNECTIONS

A. Gas piping installation requirements are specified in **Section 221124 "Facility Natural-Gas Piping."** Drawings indicate general arrangement of piping, fittings, and specialties. Connect gas piping with union or flange and appliance connector valve.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Water piping installation requirements are specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties. Connect water piping with union and ball valve.

D. Vent Connection, Noncondensing, Gas-Fired Furnaces: Connect Type B vents to furnace vent connection and extend outdoors. Type B vents and their installation requirements are specified in Section 235123 "Gas Vents."

E. Vent and Outside-Air Connection, Condensing, Gas-Fired Furnaces: Connect plastic piping vent material to furnace connections and extend outdoors. Terminate vent outdoors with a cap and in an arrangement that will protect against entry of birds, insects, and dirt.

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

   a. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
   b. CPVC Piping: Join according to ASTM D2846/D2846M, Appendix.
   c. PVC Pressure Piping: Join schedule number ASTM D1785PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.

4. Slope pipe vent back to furnace or to outside terminal.

3.3 DUCTWORK CONNECTIONS

A. Connect ducts to furnace with flexible connector. Comply with requirements in Section 233300 "Air Duct Accessories."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Perform electrical test and visual and mechanical inspection.
2. Leak Test: After installation, charge systems with refrigerant and test for leaks. Repair leaks, replace lost refrigerant, and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
4. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

END OF SECTION 235416.13

SECTION 235523.13 - LOW-INTENSITY, GAS-FIRED, RADIANT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Forced-draft heaters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power**, signal, and control** wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of radiant heaters that fail in materials or workmanship within specified warranty period.

1. Warranty Period: All warranty periods listed below are from date of Substantial Completion.

a. Burner Assembly: **10** years.
b. Combustion and Emitter Tubes: **10** years.
c. Heater Controls: Two year(s).

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. CSA certified, with CSA Seal and certification number clearly visible on units indicating compliance with ANSI Z83.20/CSA 2.34.

B. UL listed and labeled, with UL label clearly visible on units indicating compliance with ANSI Z83.20/CSA 2.34.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 FORCED-DRAFT HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Detroit Radiant Products Company.
2. Reznor
3. Roberts-Gordon, Inc.
4. Solaronics, Inc.

B. Description: Factory-assembled, **indoor**, overhead-mounted, electrically controlled, low-intensity, infrared radiant heating units using gas combustion. Heater to have all necessary factory-installed wiring and piping required prior to field installation and startup.

C. Fuel Type: Design burner for **natural** gas having characteristics same as those of gas available at Project site.

D. Burner Assembly:

1. Combustion-Air Inlet:

a. Non-ducted, unvented.
b. Ducted horizontal to outdoors through sidewall with vent caps.

2. Ignition System: **Direct spark** with flame rod sensing capabilities **and self-diagnostic control module**.

E. Combustion Chamber: 4-inch- (100-mm-) diameter, **16**-gage, heat treated **titanium-coated aluminized-** steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish.
1. Combustion Tubing to meet MIL 500 hour salt spray test.

F. Emitter Tube: 4-inch- (100-mm-) diameter, **12**-gage, **hot-rolled-** steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish. **Emitter tubing shall be equipped with baffles to maximize heating efficiency.**

1. Tubing Connections: **Compression couplings made from aluminized or stainless steel**.

2. **90**-degree-bend emitter steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish.

G. Reflector: **Polished aluminum** or **Polished stainless steel**, with end caps. Shape to control radiation from tubing for uniform intensity at floor level with 100 percent cutoff above centerline of tubing. Reflectors or entire heater shall accommodate rotational adjustment from horizontal to a minimum 45-degree tilt from vertical.
1. Reflector geometrically shaped for not less than 91.7% reflectional efficiency.

H. Capacities and Characteristics:

1. Refer to mechanical schedules on drawings.

2.3 CONTROLS AND SAFETIES

A. Gas Control Valve: **Two**-stage, regulated redundant 24-V ac gas valve that contains pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

B. Failure Safeguards: 100 percent shutoff of gas flow in the event of flame or power failure.

C. Pre-purge of **30** seconds of air control system prior to burner ignition. 120 seconds of post-purge to remove products of combustion.

D. Safety lockout of burner after **three consecutive ignition failures**.

E. Blocked Vent Safety: Differential pressure switch in burner safety circuit to stop burner operation with high discharge or suction pressure.

F. Control Panel Interlock: Stops burner if panel is open.

G. Indicator Lights: **"Burner-on"** indicator lights.

H. Thermostat:
1. Single-stage, wall-mounted type with 50 to 90 deg F (10 to 32 deg C) operating range and fan on switch.

   a. Control transformer, integrally mounted.

2. Two-stage, wall-mounted type with 50 to 90 deg F (10 to 32 deg C) operating range and fan on switch.

   a. Control transformer, integrally mounted.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment Installation: Install gas-fired, radiant heaters and associated gas features and systems according to **NFPA 54**.

B. Suspended Units: **Suspend from substrate using rigid hanger kits and building attachments** or **Mount to substrate using manufacturer's rigid mounting kits or custom fabricated brackets**.

1. Restrain the unit to resist seismic acceleration. Comply with requirements for seismic-restraint devices specified in Section 230548.13 "Vibration Controls for HVAC."
2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

C. Maintain manufacturers' recommended clearances for combustibles.

D. Gas Piping: Comply with **Section 221124 "Facility Natural-Gas Piping."** Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

1. Gas Connections: Connect gas piping to radiant heaters according to **NFPA 54**.

E. Where installing piping adjacent to gas-fired, radiant heaters, allow space for service and maintenance.

F. Vent Connections: Comply with Section 233113 "Metal Ducts" and with Section 235123 "Gas Vents."

G. Electrical Connections: Comply with applicable requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Verify bearing lubrication.
3. Verify proper motor rotation.
4. Test Reports: Prepare a written report to record the following:

a. Test procedures used.
b. Test results that comply with requirements.
c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

B. Gas-fired, radiant heaters will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.3 ADJUSTING

A. Adjust initial-temperature set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

END OF SECTION 235523.13

SECTION 236200 - PACKAGED COMPRESSOR AND CONDENSER UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Compressor and condenser units, air cooled, 1 to 5 tons (3.5 to 17.6 kW).

1.2 ACTION SUBMITTALS

A. Product Data: For each compressor and condenser unit.

B. Shop Drawings: For compressor and condenser units.

C. Delegated Design Submittal: For compressor and condenser units indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
3. Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
4. Indicate compliance with "Performance Requirements" Article.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Seismic Qualification Data: Certificates for compressor and condenser units, accessories, and components, from manufacturer.

C. Startup service reports.

D. Field quality-control reports.

E. Warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-In-Place Concrete."

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

C. Coordinate installation of steel dunnage and metal work platforms. These items are specified in Section 051200 "Structural Steel Framing," and Section 055000 "Metal Fabrications."

D. Coordinate location of piping and electrical rough-ins.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of compressor and condenser units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: **10** years from date of Substantial Completion.
2. Warranty Period (Compressor Only): **Five** years from date of Substantial Completion.
3. Warranty Period (Components Other Than Compressor): **Five** years from date of Substantial Completion.
4. Warranty Period (Condenser Coil Only): **Five** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design **vibration isolation**.

B. Fabricate and label refrigeration system in accordance with ASHRAE 15 and ASHRAE 34.

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 COMPRESSOR AND CONDENSER UNITS, AIR COOLED, 1 TO 5 TONS (3.5 TO 17.6 kW)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Global Corporation.
2. Lennox.

3. Trane.

B. Description: Factory assembled and tested; consisting of compressor, condenser coil, fan, motors, refrigerant reservoir, and operating controls.

C. Compressor Type: Scroll, hermetically sealed, with rubber vibration isolators.

1. Motor: **Variable** speed, and includes thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
2. Two-Speed Compressor: Include manual-reset, high-pressure switch and automatic-reset, low-pressure switch.
3. Accumulator: Suction tube.

D. Condenser Coil: Seamless copper-tube, **aluminum**-fin coil; with removable drain pan and brass service valves with service ports.

E. Condenser Fan: Direct-drive, metal propeller fan; with permanently lubricated, totally enclosed fan motor with thermal-overload protection .

F. Accessories:

1. Crankcase heater.
2. Cycle Protector: Automatic-reset timer to prevent rapid compressor cycling.
3. **Electronic programmable thermostat** to control compressor and condenser unit and evaporator fan.
4. Evaporator Freeze Thermostat: Temperature-actuated switch that stops unit when evaporator reaches freezing temperature.
5. Filter-dryer.
6. High-Pressure Switch: Automatic-reset switch cycles compressor off on high refrigerant pressure.
7. Liquid-line solenoid.
8. Low-Ambient Controller.
9. Low-Pressure Switch: Automatic-reset switch cycles compressor off on low refrigerant pressure.
10. Plastic mounting base.
11. Precharged and preinsulated suction and liquid tubing.
12. Sound Hood: Wraps around sound attenuation cover for compressor.
13. Thermostatic expansion valve for installation at evaporator coil.
14. Fixed orifice for installation at evaporator coil.
15. Time-Delay Relay: Continues operation of evaporator fan after compressor shuts off.
16. Reversing valve.

G. Unit Casing: Galvanized steel, finished with **baked enamel**; with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Mount service valves, fittings, and gauge ports on exterior of casing.

H. Capacities and Characteristics:

1. Refer to mechanical schedules on drawings.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 SOURCE QUALITY CONTROL

A. Performance Ratings: Certify capacity performance ratings of compressor and condenser units in accordance with **AHRI 210/240** and **AHRI 340/360**.

B. Sound-Power Level Ratings: Factory test sound-power-level ratings in accordance with **AHRI 270** and **AHRI 370**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of compressor and condenser units.

B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where compressor and condenser units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated.

B. Install roof-mounting units on equipment supports specified in Section 077200 "Roof Accessories."

C. Equipment Mounting:

1. Install compressor and condenser units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-In-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548.13 "Vibration Controls for HVAC."

3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Loose Components: Install piping specialties, electrical components, devices, and accessories that are not factory mounted.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping in Section 232300 “Refrigerant Piping.” Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

C. Connect precharged refrigerant tubing to unit's quick-connect fittings. Install tubing so it does not interfere with access to unit. Install furnished accessories.

D. Connect refrigerant piping to air-cooled compressor and condenser units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Section 232300 "Refrigerant Piping."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 STARTUP SERVICE

A. **Perform** startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions and perform the following:

   a. Inspect for physical damage to unit casing.
   b. Verify that access doors move freely and are weathertight.
   c. Clean units and inspect for construction debris.
   d. Verify that all bolts and screws are tight.
   e. Adjust vibration isolation and flexible connections.
   f. Verify that controls are connected and operational.

B. Start unit in accordance with manufacturer's written instructions and complete manufacturer's startup checklist.

C. Measure and record airflow and air temperature rise over coils.

D. Verify operation of condenser capacity control device.

E. Verify that vibration isolation and flexible connections prevent vibration transmission to structure.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: **Engage** a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:

1. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
2. Leak Test: After installation, charge system with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor operation and unit operation, product capability, and compliance with requirements.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Verify manufacturer's required airflow over coils.

C. Verify that vibration isolation and flexible connections prevent vibration transmission to structure.

D. Compressor and condenser units will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.8 DEMONSTRATION

A. **Train** Owner's maintenance personnel to adjust, operate, and maintain compressor and condenser units.

END OF SECTION 236200

SECTION 237339 - INDOOR, DIRECT-FIRED HEATING AND VENTILATING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Indoor, direct-fired heating and ventilating units.

1.2 ACTION SUBMITTALS

A. Product Data: For each indoor, direct, gas-fired heating and ventilating unit.

B. Shop Drawings: For each indoor, direct, gas-fired heating and ventilating unit.

1. Include plans, elevations, sections, and **mounting** details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of gas-fired heating and ventilating units, as well as procedures and diagrams.
4. Include diagrams for power, signal, and control wiring.

C. Delegated Design Submittal: For vibration isolation**, supports,** indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Sample Warranty: For manufacturer's warranty.

C. Seismic Qualification Data: Certificates for indoor, direct, gas-fired heating and ventilating units, accessories, and components, from manufacturer.

D. Startup service reports.

E. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For direct, gas-fired heating and ventilating units to include in emergency, operation, and maintenance manuals.

1.5 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of direct-fired heating and ventilating units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Entire Unit: Manufacturer's standard, but not less than **one** year(s) from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than **five** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of units and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation**, supports**, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

2.2 CAPACITIES AND CHARACTERISTICS

A. Refer to mechanical schedules on drawings.

2.3 INDOOR, DIRECT-FIRED HEATING AND VENTILATING UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aaon

2. Carrier
3. REZNOR, a brand of Nortek Global HVAC.
4. Rupp Air Management
5. Rapid Engineering, Inc.
6. Trane Inc.

B. Unit Casings:

1. General Fabrication Requirements for Casings:

   a. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
   b. Casing Joints: Sheet metal screws or pop rivets, factory sealed with water-resistant sealant.
   c. Heating and Ventilating Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

2. Configuration: Horizontal unit with **horizontal** discharge for **suspended** installation.

   a. Discharge Section, Cowls: Trapezoidal cowls with horizontal louvers.
   b. Discharge Section, Plenum: Plenum with three sides louvered.
   c. Discharge Section, Down-Discharge: Down-discharge plenum insulated with 1-inch (25-mm), 1.5-lb/cu. ft. (24.0-kg/cu. m) fibrous glass.

3. Double-Wall Construction:

   a. Outside Casing Wall: **Galvanized steel**, minimum **18 gauge (1.3 mm)** thick, with **manufacturer's standard finish**].
   b. Inside Casing Wall:

      1) Inside Casing, Burner Section: **Galvanized steel**, solid, minimum [**14-gauge (0.759-mm)**] thick steel.
      2) Inside Casing, All Other Sections: **Galvanized steel solid** steel.
   c. Casing Insulation:

      1) Materials: **Glass-fiber blanket or board insulation, Type I or Type II ASTM C1071**.
      2) Insulation Thickness: **1 inch (25 mm)**.
      3) Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.

   d. Airstream Surfaces: Surfaces in contact with airstream are to comply with requirements in ASHRAE 62.1.

4. Inspection and Access Panels and Access Doors:

   a. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.
   b. Inspection and Access Panels:

1) Fasteners: Two or more camlock type for panel lift-out operation. Arrangement is to allow panels to be opened against air-pressure differential.
2) Gasket: Neoprene, applied around entire perimeters of panel frames.
3) Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

c. Access Doors:

1) Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
2) Gasket: Neoprene, applied around entire perimeters of panel frames.
3) Size: At least **24 inches (600 mm)** wide by full height of unit casing.

d. Locations and Applications:

1) Fan Section: **Doors**.
2) Access Section: Doors.
3) Gas-Fired Burner Section: **Door**].
4) Damper Section: **Doors**.
5) Filter Section: **Doors** large enough to allow periodic removal and installation of filters.
6) Mixing Section: Doors.

C. Fan, Drive, And Motor:

1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
2. Fans: Centrifugal, rated in accordance with AMCA 210; galvanized steel; mounted on solid-steel shaft.

a. Shafts: With field-adjustable alignment.

1) Turned, ground, and polished hot-rolled steel with keyway.

b. Shaft Bearings: Heavy-duty**, self-aligning, permanently lubricated ball bearings** with an **L50** rated life of **100,000** hours in accordance with ABMA 9.
c. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
d. Mounting: For internal vibration isolation. Factory-mount fans with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of **1 inch (25 mm)**.
e. Shaft Lubrication Lines: Extended to a location outside the casing.
f. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches (89 mm) wide, attached to two strips of minimum 2-3/4-inch- (70-mm-) wide by 0.028-inch- (0.7-mm-) thick, galvanized-steel sheet.

1) Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives are to comply with UL 181, Class 1.

3. Drive: Factory-mounted V-belt drive, with adjustable alignment and belt tensioning, and with **1.5** service factor based on fan motor.

    a. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.
    b. Belts: Oil resistant, non-sparking and nonstatic; in matched sets for multiple-belt drives.
    c. Belt Guards: Comply with requirements specified by OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards"; **0.146-inch-(2.7-mm-)** thick, **3/4-inch (20-mm)** diamond-mesh wire screen, welded to steel angle frame; prime coated.

4. Motors:

    a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
    b. Motor Sizes: Maximum sizes as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
    c. Enclosure Type: **Open, dripproof**.
    d. Enclosure Materials: **Cast iron**.

    e. Efficiency: Premium efficient as defined in NEMA MG 1.
    f. NEMA Design: **2**.
    g. Motor Pulleys: Adjustable pitch for use with **5**-hp motors and smaller; fixed pitch for use with motors larger than **5** hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.

D. Air Filtration:

1. Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."
2. Panel Filters:

    a. Description: **Pleated** factory-fabricated, self-supported, disposable air filters with holding frames.
    b. Filter Unit Class: UL 900.
    c. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
    d. Filter-Media Frame: **Beverage board** with perforated metal retainer, or metal grid, on outlet side.

3. Cleanable Filters:

    a. Cleanable metal mesh.

4. Adhesive, Sustainability Projects: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.
5. Adhesive, LEED for Schools Projects: As recommended by air-filter manufacturer and that complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

6. Side-Access Filter Mounting Frames:

   a. Particulate Air Filter Frames: Match inner casing and outer casing material, and insulation thickness. **Galvanized-steel** track.

      1) Sealing: Incorporate positive-sealing device to ensure seal between gasketed material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

E. Dampers:

1. Comply with requirements in Section 230923.12 "Control Dampers."
2. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, **galvanized-steel** dampers with compressible jamb seals and extruded-vinyl blade edge seals in o**pposed**-blade arrangement with **zinc-plated**]teel operating rods rotating in **sintered bronze or nylon** bearings mounted in a single **galvanized-steel** frame, and with operating rods connected with a common linkage. Leakage rate is not to exceed **4 cfm/sq. ft. (20 L/s per sq. m) at 1-inch wg (250 Pa) and 8 cfm/sq. ft. (40 L/s per sq. m) at 4-inch wg (1.0 MPa), leakage Class 1, tested, rated, and labeled in accordance with AMCA 511**.
3. Damper Operators: Comply with requirements in Section 230923.12 "Control Dampers."
4. Electronic Damper Operators:

   a. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
   b. Electronic damper position indicator is to have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
   c. Operator Motors:

      1) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
      2) Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
      3) Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

   d. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
   e. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
   f. Size dampers for running torque calculated as follows:

      1) Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
      2) Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.

3) Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. (49.6 kg-cm/sq. m) of damper.
4) Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
5) Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
6) Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.

g. Coupling: V-bolt and V-shaped, toothed cradle.
h. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
i. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.

F. Direct-Fired Gas Burner:

1. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54
2. CSA Approval: Designed and certified by and bearing label of CSA.
3. Burners: **Aluminized steel with stainless steel inserts**.

a. Rated Minimum Turndown Ratio: as indicated on drawings.
b. Fuel: **Natural** gas.
c. Ignition: Electronically controlled electric spark with flame sensor.
d. Gas Control Valve: **Modulating**.
e. Gas Train: Regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, **electronic**-modulating temperature control valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
f. High-Altitude Model Kit: For Project elevations more than 2000 feet (610 m) above sea level.

4. Heat-Exchanger and Drain Pan: Stainless steel.
5. Safety Controls:

a. Gas Manifold: Safety switches and controls complying with ANSI standards **and FM Global**.
b. Vent Flow Verification: **Differential pressure switch to verify open vent**.
c. High Limit: Thermal switch or fuse to stop burner.
d. Purge-period timer is to automatically delay burner ignition and bypass low-limit control.
e. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
f. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
g. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.
h. Control Transformer: 24 V ac.

G. Unit Control Panel:

1. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.
2. Control Panel: Surface-mounted remote panel, with engraved plastic cover and the following lights and switches:

    a. **On-off-auto** fan switch.
    b. Heat-vent-off switch.
    c. Supply-fan operation indicating light.
    d. Heating operation indicating light.
    e. Thermostat.
    f. Damper position potentiometer.
    g. Dirty-filter indicating light operated by unit-mounted differential pressure switch.
    h. Safety-lockout indicating light.
    i. Enclosure: NEMA 250, **Type** 2

H. Controls:

1. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for control equipment and sequence of operation.
2. Control Devices:

    a. Remote Thermostat: Adjustable room thermostat with temperature readout.
    b. Remote Setback Thermostat: Adjustable room thermostat without temperature readout.
    c. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
    d. Fire-Protection Thermostats: Fixed or adjustable settings to operate at not less than 75 deg F (24 deg C) above normal maximum operating temperature.
    e. Timers, Seven Day:

        1) Programming-switch timer with synchronous-timing motor and seven-day dial.
        2) Continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover.
        3) Multiple-switch trippers.
        4) Minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.

3. Fan Control, Interlocked: Fan to start automatically with exhaust fan(s) to which this heating and ventilating unit is associated for makeup air.
4. Outdoor-Air Damper Control, 100 Percent Outdoor-Air Units: Outdoor-air damper is to open when supply fan starts, and close when fan stops.

5. Temperature Control:

    a. Operates gas valve to maintain discharge-air temperature with factory-mounted sensor in blower outlet.
    b. Burner Control: Two or four steps of control using one or two burner sections in series.
    c. Hardwired Points:

1) Room temperature.
2) Discharge-air temperature.
3) Burner operating.

2.4 SOURCE QUALITY CONTROL

A. **AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311.**

B. **Fan Sound Performance Rating: Factory test and rate fan sound performance rating in accordance with AMCA 300/301.**

C. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

2.5 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

B. Equipment Mounting:

1. Install heating and ventilating units on cast-in-place concrete equipment bases. Coordinate sizes and locations of concrete bases with actual equipment provided. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Suspended Units: Suspend **and brace** units from structural-steel support frame using threaded steel rods and spring hangers. Coordinate sizes and locations of structural-steel support

members with actual equipment provided. Comply with requirements for vibration isolation devices specified in **Section 230548.13 "Vibration Controls for HVAC."**

D. Install gas-fired units in accordance with NFPA 54, "National Fuel Gas Code."

E. Install controls and equipment shipped by manufacturer for field installation with direct, gas-fired heating and ventilating units.

F. Install seismic restraints in accordance with manufacturer's written instructions.

3.2 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Gas Piping: Comply with requirements in **Section 221124 "Facility Natural-Gas Piping."** Connect gas piping with shutoff valve and union, and with sufficient clearance for burner removal and service. Make final connections of gas piping to unit with corrugated, stainless steel tubing flexible connectors complying with ANSI LC 1/CSA 6.26 equipment connections.

B. Where installing piping adjacent to heating and ventilating units, allow space for service and maintenance.

3.3 DUCTWORK CONNECTIONS

A. Connect supply ducts to direct-fired heating and ventilating units with flexible duct connectors. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 STARTUP SERVICE

A. **Perform** startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions and perform the following:

   a. Inspect for visible damage to burner combustion chamber.
   b. Inspect casing insulation for integrity, moisture content, and adhesion.
   c. Verify that clearances have been provided for servicing.
   d. Verify that controls are connected and operable.
   e. Verify that filters are installed.
   f. Purge gas line.
   g. Inspect and adjust vibration isolators.
   h. Verify bearing lubrication.
   i. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
   j. Adjust fan belts to proper alignment and tension.
   k. Start unit in accordance with manufacturer's written instructions.

2. Complete startup sheets and attach copy with Contractor's startup report.
3. Inspect and record performance of interlocks and protective devices; verify sequences.
4. Operate unit for run-in period recommended by manufacturer.
5. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:

   a. Measure gas pressure at manifold.
   b. Measure combustion-air temperature at inlet to combustion chamber.
   c. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

6. Calibrate thermostats.
7. Adjust and inspect high-temperature limits.
8. Inspect dampers, if any, for proper stroke and interlock with return-air dampers.
9. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
10. Measure and record airflow. Plot fan volumes on fan curve.

11. Verify operation of remote panel, including pilot-operation and failure modes. Inspect the following:

    a. High-limit heat.
    b. Alarms.

12. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
13. Verify drain-pan performance.
14. Verify outdoor-air damper operation.

3.7 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within **12** months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to **two** visits to Project during other-than-normal occupancy hours for this purpose.

3.8 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: **Contractor** will engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

    1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
    2. Test and adjust controls and safeties.

C. Units will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. **Train** Owner's maintenance personnel to adjust, operate, and maintain heating and ventilating units.

END OF SECTION 237339

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Split-system air-conditioners.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.3 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: **Five** year(s) from date of Substantial Completion.
b. For Parts: **Five** year(s) from date of Substantial Completion.
c. For Labor: **Five** year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SPLIT-SYSTEM AIR-CONDITIONERS

A. Manufacturers: Subject to compliance with requirements, **provide products by one of the following**:
1. Daikin
2. LG
3. Mitsubishi Electric & Electronics USA, Inc.
4. Mitsubishi Heavy Industries America, Inc.
5. Panasonic Corp (Sanyo)
6. SANYO North America Corporation.
7. Samsung HVAC.
8. Trane.
9. YORK; brand of Johnson Controls International plc, Building Solutions North America.

B. Indoor Units (5 tons (18 kW) or Less:

1. Concealed Evaporator-Fan Components:

a. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
b. Insulation: Faced, glass-fiber duct liner.
c. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
d. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm); leak tested to 300 psig (2070 kPa) underwater; with a two-position control valve.
e. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
f. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
g. Fan Motors:

1) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230500 "Common Work Results for HVAC."
2) Multitapped, multispeed with internal thermal protection and permanent lubrication.
3) Wiring Terminations: Connect motor to chassis wiring with plug connection.

h. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
i. Filters: Permanent, cleanable.
j. Condensate Drain Pans:

1) Fabricated with **one** or **two** percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

a) Length: Extend drain pan downstream from leaving face **to comply with ASHRAE 62.1**.
b) Depth: A minimum of **2 inches (50 mm)** deep.

2) Single-wall, **galvanized** or **stainless**-steel sheet.
3) Double-wall, **galvanized** or **stainless**-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
4) Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on **both ends** of pan.

5) Pan-Top Surface Coating: Asphaltic waterproofing compound.
6) Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

C. Outdoor Units (5 tons (18 kW) or Less)

1. Air-Cooled, Compressor-Condenser Components:

a. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
b. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

1) Compressor Type: Scroll.
2) Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
3) Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.

c. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
d. Fan: Aluminum-propeller type, directly connected to motor.
e. Motor: Permanently lubricated, with integral thermal-overload protection.
f. Low Ambient Kit: Permits operation down to 45 deg F (7 deg C).
g. Mounting Base: Polyethylene.

D. Accessories:

1. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."
2. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
3. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

a. Compressor time delay.
b. 24-hour time control of system stop and start.
c. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
d. Fan-speed selection including auto setting.

4. Automatic-reset timer to prevent rapid cycling of compressor.
5. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
6. Drain Hose: For condensate.
7. Monitoring:

a. Monitor constant and variable motor loads.
b. Monitor variable-frequency-drive operation.
c. Monitor economizer cycle.
d. Monitor cooling load.
e. Monitor air distribution static pressure and ventilation air volumes.

E. Capacities and Characteristics:

1. Refer to mechanical schedules on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Equipment Mounting:

1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply **and return** ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. **Train** Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

SECTION 238239.19 - WALL AND CEILING UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Wall and ceiling unit heaters with propeller fans and electric-resistance heating coils.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include details of anchorages and attachments to structure and to supported equipment.
4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
5. Wiring Diagrams: Power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 GENERAL

A. Manufacturers: Subject to compliance with requirements, **provide products by one of the following**:

1. Berko; Marley Engineered Products.
2. Federal Pacific
3. Markel Products Company; a subsidiary of TPI Corporation.
4. Nutone
5. QMark; Marley Engineered Products.
6. Raywell
7. Singer

B. Heaters: Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

C. Electrical Components, Devices, and Accessories:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

   Motor:
   1. Comply with requirements in Section 230500 "Common Work Results for HVAC."

E. Capacities and Characteristics:
   1. Refer to mechanical schedules on drawings.

2.2 Electric Wall Heater (EWH-)-

A. Type: Fan-forced wall heater.

B. UL Listed.

C. Mounting: Surface mounted.

D. Front Cover: Louvered front cover shall be of heavy gauge steel with powder paint finish. A plug button will be provided to replace the thermostat knob and render the unit tamper-resistant.

E. Finish: All sheet metal parts, except the galvanized steel back box, shall be phosphatized, then completely painted by a powder paint process.

F. Back Box: Back box shall be heavy gauge galvanized steel and shall contain knockouts throughout with power leads enter.

G. Inner Frame Assembly: The heater assembly, which fits into the back box, shall consist of a heavy gauge steel fan panel to which all of the operational parts of the heater are mounted. The inner frame assembly shall be completely pre-wired.

H. Accessories: Provide surface mounting frame constructed of heavy guage steel designed to mount around back box for a finished surface installation. Slot knockouts shall be provided for power supply conduit.

I. Motor and Controls: Fan motor shall be impedance protected, permanently lubricated. Fan control shall be of bi-metallic, snap-action type and shall activate fan after heating element reaches operating temperature, and continue to operate the fan after the thermostat is satisfied and until all heated air has been discharged. The thermostat shall be single-pole type. Thermal cutout shall be self-hold (manual-reset) type designed to shut off heat in the event of overheating. Fan shall be four-bladed aluminum. A back up (end of life) thermal fuse shall be provided for additional safety.

J. On/off switch: A double-pole, single throw on/off switch shall be mounted on the back box for positive disconnect power supply. It will be completely concealed behind the front cover.

K. Heating Element: The heating element shall be of the non-glowing design consisting of 80/20 nickle-chromium resistance wire enclosed in a steel sheath to which plate fins are copper brazed. The element shall cover the entire air discharge area to ensure uniform heating of all discharged air. Warrantied for 5 years.

2.3 Electric Unit Heater (EUH-)-

A. Type: Bundled Horizontal / Downflow Unit heater.

B. UL Listed.

C. Mounting: Wall mounted.

D. Housing: Heavy gauge steel, welded and phosphatized; completely painted by a baked enamel painting process. Front and back panels shall be removable to gain full access to element, motor, and fan area. Fan guard shall be painted to match heater for appearance and durability.

E. Accessories: Furnish with wall mounting bracket.

F. Control Box: The control box, housing all heater wiring and controls, shall be located at the bottom of the heater and equipped with a swing down hinged cover to permit full access for installation and servicing without dismounting the heater.

G. Wiring: All heater and control wiring connections shall terminate in the control box. 60°C wire may be used to bring entry wiring into compartment.

H. Heating Element: Non-glowing design consisting of a special resistance wire enclosed in the steel sheath to which steel plate fins are brazed. The heating element shall cover the entire air discharge are for uniform heating. Warrantied for 5 years.

I. Thermal Cutout: Thermal Cutout shall be built into the system to automatically shut off heater in event of overheating and reactivate the heater when temperatures return to normal.

PART 3 - EXECUTION

3.1 INSTALLATION OF WALL AND CEILING UNIT HEATERS

A. Install wall and ceiling unit heaters to comply with NFPA 90A.

B. Install wall and ceiling unit heaters level and plumb.

C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

D. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 238239.19

SECTION 260010 - SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements generally applicable to all electrical Work on the Project, including but not limited to Work specified in Divisions 26, 27, and 28.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.

1.2 COORDINATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify **Owner** no fewer than **fourteen** days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without **Owner's** written permission.
3. Coordinate interruption with systems impacted by outage including, but not limited to, the following:

   a. Exercising generators.
   b. Emergency lighting.
   c. Fire-alarm systems.

4. Arrange to provide temporary emergency and standby electrical **service** so facility may remain occupied during the outage in accordance with requirements specified in Section 015000 "Temporary Facilities and Controls." Coordinate power requirements with Owner.

B. Interruption of Existing Telephone Service: Do not interrupt telephone service to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify **Owner** no fewer than **fourteen** days in advance of proposed interruption of telephone service.
2. Do not proceed with interruption of telephone service without **Owner's** written permission.

C. Interruption of Existing Internet Service: Do not interrupt internet service to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify **Owner** no fewer than **fourteen** days in advance of proposed interruption of telephone service.
2. Do not proceed with interruption of telephone service without **Owner's** written permission.

D. Interruption of Existing Security System: Do not interrupt security system to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify **Owner** no fewer than **fourteen** days in advance of proposed interruption of telephone service.
2. Do not proceed with interruption of telephone service without **Owner's** written permission.

E. Interruption of Existing Fire-Alarm System: Do not interrupt fire-alarm system to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify **Owner** no fewer than **fourteen** days in advance of proposed interruption of telephone service.
2. Do not proceed with interruption of telephone service without **Owner's** written permission.

1.3 PREINSTALLATION MEETINGS

A. Electrical Preconstruction Conference: Schedule conference with Architect and Owner, not later than **10** days after Notice to Proceed. Agenda topics include, but are not limited to, the following:

1. Electrical installation schedule.
2. Status of power system studies.
3. Value analysis proposals and requests for substitution of electrical equipment.
4. Utility work coordination and class of service requests.
5. Commissioning activities.
6. Sustainability activities.

B. Communications Preconstruction Conference: Schedule conference with Architect and Owner not later than **10** days after Notice to Proceed. Agenda topics include, but are not limited to, the following:

1. Installation schedule for communications systems.
2. Value analysis proposals and requests for substitution of communications equipment.
3. Utility services work coordination and monitoring service requests.
4. Commissioning activities.
5. Sustainability activities.

C. Electronic Safety and Security Preconstruction Conference: Schedule conference with Architect and Owner not later than **10** days after Notice to Proceed. Agenda topics include, but are not limited to, the following:

1. Installation schedule for security, fire-alarm, and other life-safety systems.
2. Value analysis proposals and requests for substitution of electronic safety and security equipment.
3. Monitoring services work coordination and monitoring service requests.
4. Commissioning activities.
5. Sustainability activities.

1.4 SEQUENCING

A. Conduct and submit results of power system studies before submitting product data and shop drawings for electrical equipment.

1.5 SCHEDULING

A. Schedule uninterrupted services two week prior to interruption.

1.6 ACTION SUBMITTALS

A. Coordination Drawings for Structural Supports: Show coordination of structural supports for equipment and devices, including restraints and bracing for control of seismic and wind loads, with other systems, equipment, and structural supports in the vicinity.

B. Coordination Drawings for Ceiling Areas: Where indicated on drawings, provide reflected ceiling plan(s), supplemented by sections and other details, drawn to scale, in accordance with Section 013100 "Project Management and Coordination," on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which equipment and suspension systems will be attached.
3. Size and location of access panels on ceilings.
4. Elevation, size, and route of sprinkler piping.
5. Elevation, size, and route of plumbing piping.
6. Elevation, size, and route of ductwork.
7. Elevation, size, and route of cable tray.
8. Elevation, size, and route of conduit.
9. Elevation and size of wall-mounted and ceiling-mounted equipment.
10. Access panels.
11. Sprinklers.
12. Air inlets and outlets.
13. Control modules.
14. Luminaires.
15. Communications devices.
16. Speakers.
17. Security devices.
18. Fire-alarm devices.
19. Indicate clear dimensions for maintenance access in front of equipment.
20. Indicate dimensions of fully open access doors.

C. Coordination Drawings for Cable Tray Routing: Reflected ceiling plan(s), supplemented by sections and other details, drawn to scale, in accordance with Section 013100 "Project Management and Coordination," on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Elevation, size, and route of cable trays.
2. Relationships between components and adjacent structural, electrical, and mechanical elements.
3. Vertical and horizontal offsets and transitions.
4. Elevation and size of sleeves for wall, ceiling, and floor cable penetrations.
5. Elevation of ceilings and size of ceiling tiles.
6. Locations of access panels on ceilings.
7. Locations where cable tray crosses or parallels sprinkler piping.
8. Locations where cable tray crosses plumbing piping.
9. Locations where cable tray crosses or parallels ductwork.
10. Locations of access panels on ductwork.
11. Locations where cable tray crosses conduit.
12. Items blocking access around cable trays, including the following:

    a. Light fixtures.
    b. Speakers.
    c. Fire-alarm devices.
    d. Power outlets.
    e. Wall-mounted equipment.
    f. Equipment racks.
    g. Furniture.
    h. Door swings.
    i. Building features.

13. Indicate clear dimension between cable tray and walls or obstructions that are closer than 10 ft (3 m).
14. Highlight locations where cable tray is greater than 3 ft (1 m) above ceilings. Explain how personnel access will be accommodated for cable tray maintenance.

D. Coordination Drawings for Conduit Routing: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

E. Coordination Drawings for Bus Assembly Routing: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Scaled bus-assembly layouts and relationships between components and adjacent structural, mechanical, and electrical elements.
2. Vertical and horizontal enclosed bus-assembly runs, offsets, and transitions.
3. Clearances for access above and to the side of enclosed bus assemblies.
4. Vertical elevation of enclosed bus assemblies above the floor or bottom of structure.

5. Support locations, type of support, and weight on each support.
6. Location of adjacent construction elements, including luminaires, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

F. Coordination Drawings for Large Equipment Indoor Installations:

1. Location plan, drawn to scale, showing heavy equipment or truck access paths to loading dock or other freight access into building. Indicate available width and height of doors or openings.
2. Floor plan for entry floor and floor where equipment is located, drawn to scale, showing heavy equipment access paths for maintenance and replacement, with the following items shown and coordinated with each other, based on input from installers of the items involved:

    a. Dimensioned concrete bases, outlines of equipment, conduit entries, and grounding equipment locations.
    b. If freight elevator must be used, indicate width and height of door and depth of car. Indicate if large equipment must be tipped to use elevator.
    c. Dimensioned working clearances and dedicated areas below and around electrical equipment where obstructions and tripping hazards are prohibited.

3. Reflected ceiling plans for entry floor and floor where equipment is located, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

    a. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways, busways, and seismic bracing.
    b. Location of lighting fixtures, sprinkler piping and sprinklers, ducts and diffusers, and other obstructions, indicating available overhead clearance.
    c. Dimensioned working clearances and dedicated areas above and around electrical equipment where foreign systems and equipment are prohibited.

G. Coordination Drawings for Large Equipment Outdoor Installations:

1. Utilities site plan, drawn to scale, showing heavy equipment or truck access paths for maintenance and replacement, with the following items shown and coordinated with each other, based on input from installers of the items involved:

    a. Fences and walls, dimensioned concrete bases, outlines of equipment, conduit entries, and grounding and bonding locations.
    b. Indicate clear dimensions for fence gates and wall openings.
    c. Indicate depth and type of ground cover, and locations of trees, shrubbery, and other obstructions in access path.
    d. Indicate clear height below tree branches, overhead lines, bridges, and other overhead obstructions in access path, or where cranes and hoists will be needed to handle large electrical equipment.
    e. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways, busways, and seismic bracing.
    f. Dimensioned working clearances and dedicated areas around electrical equipment.

H. Coordination Drawings for Duct Banks:

1. Show duct profiles and coordination with other utilities and underground structures.
2. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

1.7 INFORMATIONAL SUBMITTALS

A. Electrical Installation Schedule: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for electrical installation Work to Owner and Architect including, but not limited to, milestone dates for the following activities:

1. Submission of power system studies.
2. Submission of specified coordination drawings.
3. Submission of action submittals specified in Division 26.
4. Orders placed for major electrical equipment.
5. Arrival of major electrical equipment on-site.
6. Preinstallation meetings specified in Division 26.
7. Utility service outages.
8. Utility service inspection and activation.
9. Mockup reviews.
10. Closing of walls and ceilings containing electrical Work.
11. System startup, testing, and commissioning activities for major electrical equipment.
12. System startup, testing, and commissioning activities for emergency lighting.
13. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
14. Pouring of concrete housekeeping pads for electrical equipment and testing of concrete samples.
15. Requests for special inspections.
16. Requests for inspections by authorities having jurisdiction.

B. Installation Schedule for Communications Systems: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for installation of the communications Work to Owner and Architect including, but not limited to, milestone dates for the following activities:

1. Submission of specified coordination drawings.
2. Submission of action submittals specified in Division 27.
3. Orders placed for major equipment.
4. Arrival of major equipment on-site.
5. Preinstallation meetings specified in Division 27.
6. Telephone and internet service outages.
7. Telephone and internet service inspection and activation.
8. Mockup reviews.
9. Closing of walls and ceilings containing the communications Work.
10. System startup, testing, and commissioning activities for communications equipment.
11. System startup, testing, and commissioning activities for the Work specified in other divisions that depends on the Work specified in Division 27.
12. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
13. Requests for special inspections.
14. Requests for inspections by authorities having jurisdiction.

C. Installation Schedule for Security, Fire-Alarm, and Other Life-Safety Systems: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for installation of security, fire-alarm, and the other life-safety Work to Owner and Architect including, but not limited to, milestone dates for the following activities:

1. Submission of specified coordination drawings.
2. Submission of action submittals specified in Division 28.
3. Orders placed for major equipment.
4. Arrival of major equipment on-site.
5. Preinstallation meetings specified in Division 28.
6. Security and fire-alarm system outages.
7. Security and fire-alarm system inspection and activation.
8. Mockup reviews.
9. Closing of walls and ceilings containing the security and fire-alarm Work.
10. System startup, testing, and commissioning activities for security and fire-alarm equipment.
11. System startup, testing, and commissioning activities for fire-alarm interfaces with the Work specified in other divisions.
12. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
13. Requests for special inspections.
14. Requests for inspections by authorities having jurisdiction.

D. Welding certificates.

E. Seismic Performance Certificates: Provide special certification for designated seismic systems as required to meet requirements specified in Section 018123 "Facility Seismic and Wind Criteria" for all designated seismic systems identified on Drawings or in the Specifications.

1. Include the following information:

a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
d. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
e. Equipment manufacturer's written certification for each designated active electrical seismic device and system, stating that it will remain operable following the basis-of-design seismic criteria specified in Section 018123 "Facility Seismic and Wind Criteria."
f. Equipment manufacturer's written certification that components with hazardous contents maintain containment following the basis-of-design seismic criteria specified in Section 018123 "Facility Seismic and Wind Criteria."
g. Evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by qualified structural professional engineer.

F. Wind Performance Certificates: Provide special certification for systems and components designated on Drawings or in the Specifications to be subject to high wind exposure and impact damage.

1. Include the following information:

a. Provide equipment manufacturer's written certification for each designated system and component, stating that it will remain in place and operable following the design wind event and comply with requirements of authorities having jurisdiction.
b. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.

G. Qualification Statements:

1. For qualified regional manufacturer.
2. For structural professional engineer.
3. For electrical professional engineer.
4. For lighting professional engineer.
5. For EPM specialist.
6. For welder.
7. For ERMC-S-PVC raceway Installer.
8. For medium-voltage cable Installer.
9. For medium-voltage duct Installer.
10. For medium-voltage equipment Installer.
11. For electrical power monitoring Installer.
12. For switchboard Installer.
13. For EVSE Installer.
14. For generator set Installer.
15. For lightning protection system Installer.
16. For theatrical lighting Installer.
17. For exterior athletic lighting Installer.
18. For power quality specialist.
19. For low-voltage electrical testing agency and on-site electrical testing supervisor.
20. For power-limited electrical testing agency and on-site power-limited testing supervisor.
21. For structural testing and inspecting agency.
22. For outdoor pole testing and inspecting agency.
23. For luminaire photometric testing laboratory.
24. For lighting testing and inspecting agency.
25. For communications design professional.
26. For communications cable Installer.
27. For communications testing agency and on-site communications testing supervisor.
28. For security design professional.
29. For life-safety professional engineer.
30. For fire-alarm cable Installer.
31. For security testing agency and on-site security testing supervisor.
32. For fire-alarm testing agency and on-site fire-alarm testing supervisor.

1.8 CLOSEOUT SUBMITTALS

A. Facility EMP Binders:

1. Complete Set: On approved online or cloud solution and USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement.
2. Volumes 2 and 8: Reproducible hardcopy on archival quality, 28 lb (105 GSM), acid-free, bond paper.

B. Operation and Maintenance Data:

1. Provide emergency operation, normal operation, and preventive maintenance manuals for each system and equipment.

2. Include the following information:

a. Manufacturer's operating specifications.
b. User's guides for software and hardware.
c. Schedule of maintenance material items recommended to be stored at Project site.
d. Detailed instructions covering operation under both normal and abnormal conditions.
e. Time-current curves for overcurrent protective devices and manufacturer's written instructions for testing and adjusting their settings.
f. List of load-current and overload-relay heaters with related motor nameplate data.
g. List of lamp types and photoelectric relays used on the Project, with ANSI and manufacturers' codes.
h. Manufacturer's instructions for setting field-adjustable components.
i. Manufacturer's instructions for testing, adjusting, and reprogramming microprocessor controls.
j. EPSS: Manufacturer's system checklists, maintenance schedule, and maintenance log sheets in accordance with NFPA 110.
k. Exterior pole inspection and repair procedures.

C. Software and Firmware Operational Documentation: Provide software and firmware operational documentation in Facility EPM Binders, including the following:

1. Software operating and upgrade manuals.
2. Names, versions, and website addresses for locations of installed software.
3. Device address list.
4. Printout of software application and graphic screens.
5. Testing and adjusting of panic and emergency power features.
6. For lighting controls, include the following:

a. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
b. Operation of adjustable zone controls.

D. Software:

1. Program Software Backup: Provide username and password for approved online or cloud solution.
2. Provide to Owner upgrades and unrestricted licenses for installed and backup software, including operating systems and programming tools required for operation and maintenance.

1.9 MOCKUPS

A. Simple Mockups for Coordinating Accessibility of Electrical Devices around Fixed Furnishings and Equipment:

1. Depict products from all Divisions requiring coordination, including, but not limited to, fixed furnishings, casework, outlet covers and plates, HVAC controls, exposed raceway, exposed plumbing, equipment, and signage.

B. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.

PART 2 - PRODUCTS

2.1 SUBSTITUTION LIMITATIONS FOR ELECTRICAL EQUIPMENT

A. Substitution requests for electrical equipment will be entertained under the following conditions:

1. Substitution requests may be submitted for consideration prior to the Electrical Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with Project performance requirements while significantly increasing value for Owner throughout life of facility.
2. Substitution requests may be submitted for consideration concurrently with submission of power system study reports when those reports indicate that substitution is necessary for safety of maintenance personnel and facility occupants.
3. Contractor is responsible for sequencing and scheduling power system studies and electrical equipment procurement. After the Electrical Preconstruction Conference, insufficient lead time for electrical equipment delivery will not be considered a valid reason for substitution.

2.2 SUBSTITUTION LIMITATIONS FOR COMMUNICATIONS EQUIPMENT

A. Substitution requests for communications equipment will be entertained under the following conditions:

1. Substitution requests may be submitted for consideration prior to the Communications Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with Project performance requirements while significantly increasing value for Owner throughout life of facility.
2. Contractor is responsible for sequencing and scheduling equipment procurement. After the Communications Preconstruction Conference, insufficient lead time for equipment delivery will not be considered a valid reason for substitution.

2.3 SUBSTITUTION LIMITATIONS FOR ELECTRONIC SAFETY AND SECURITY EQUIPMENT

A. Substitution requests for electronic safety and security equipment will be entertained under the following conditions:

1. Substitution requests may be submitted for consideration prior to the Electronic Safety and Security Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with the Project performance requirements while significantly increasing value for Owner throughout life of facility.
2. Contractor is responsible for sequencing and scheduling equipment procurement. After the Electronic Safety and Security Preconstruction Conference, insufficient lead time for equipment delivery will not be considered a valid reason for substitution.

2.4 FACILITY ELECTRICAL MAINTENANCE PROGRAM (EMP) BINDERS

A. Description: Set of binders containing operation and maintenance data for facility's electrical equipment that was compiled during analysis of installed electrical Work for Facility EMP development.

B. Applicable Standards:

1. Regulatory Requirements: Comply with requirements in NFPA 70B.
2. General Characteristics:

a. Volume 1 - Introduction:

1) Summarize how Facility EMP analysis was performed, how data were collected, and how volumes are organized.
2) Describe Facility EMP and provide recommended policies and procedures for implementing the program and keeping it current.
3) Provide place for Owner to identify contact information for employees responsible for implementing and maintaining Facility EMP.

b. Volume 2 - Facility Safety, Hazards Awareness, and Emergency Procedures:

1) Include training requirements for employees and contractors.
2) Include list of known facility hazards impacting IT&R activities.
3) Include approval and permitting procedures for IT&R activities.
4) Include incident emergency response procedures.
5) Include emergency shutdown procedures.
6) Include electrical disaster recovery procedures.
7) Include procedures for investigating the following incidents:

a) Electrical safety incidents.
b) Equipment malfunctions.
c) Unintended operations or alarms.
d) Operation of protective devices.

c. Volume 3 - Operating Procedures for Electrical Equipment and Controls:

d. Volume 4 - Facility Diagrams and Schedules:

1) Include single-line diagrams.
2) Include grounding and bonding diagrams.
3) Include essential wiring diagrams.
4) Include system automation diagrams (SCADA, BMS, lighting, HVAC, etc.).
5) Include records of switchgear, switchboard, and panelboard schedules.
6) Include time-current curves for overcurrent protective devices.
7) Include list of load-current and overload-relay heaters with related motor nameplate data.

e. Volume 5 - Inventory of Facility Equipment Using Electrical Power:

1) Include simplified floor plans showing equipment locations.
2) Identify critical equipment (electrical or otherwise).
3) Include identifying designations and nameplate data.
4) Include warranty and maintenance contract information.

f. Volume 6 - Inventory of Facility Tools, Supplies, and Personnel Protective Equipment:

1) Include schedules of maintenance material items recommended to be stored at facility.
2) Include list of lamp types and photoelectric relays used in facility with ANSI and manufacturers' codes.
3) Include calibration and servicing data for each item.

g. Volume 7 - Inspection, Testing, and Repair (IT&R) Plan:

1) Include tables showing frequency of activities for each item.
2) Include annual schedule with activities mapped to specific days of the year.
3) Include exterior pole inspection and repair procedures.

h. Volume 8 - Inspection, Testing, and Repair (IT&R) Forms:

i. Volume 9 - Inspection, Testing, and Repair (IT&R) Procedures:

j. Volume 10 - Spare Parts List:

1) Include list of all parts required to perform IT&R procedures.
2) Identify quantities of which parts are recommended to be stored on-site.
3) Include source contact information and budget cost for each item.

k. Volume 11 - Construction Project Closeout Record Documentation:

1) Include records of power system studies and photometric studies.
2) Include records of risk assessment studies.
3) Include records of electrical system startup and commissioning activities.
4) Include records of baseline inspections and tests.

5) Include records of baseline infrared photographs with normal light photographs showing the location, direction, angle, and conditions necessary for reproducing each infrared photograph.
6) Include records of baseline settings for adjustable equipment and devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions.

B. Preinstallation Testing.

C. Evaluation and Assessment.

3.2 PREPARATION

A. Protection of In-Place Conditions.

3.3 DEVELOPMENT OF FACILITY ELECTRICAL MAINTENANCE PROGRAM (EMP)

A. Facility EMP must be developed by qualified EMP specialist.

B. Conduct Facility EMP analysis in accordance with NFPA 70B requirements.

1. Renovation Projects:

a. Facility diagrams must include connected existing equipment for entire facility where known. Areas of uncertainty should be clearly indicated.
b. Obtain copies of existing operation and maintenance data and existing Facility EMP information from Owner.
c. Facility EMP analysis should identify existing equipment that does not have available operation and maintenance data, and should explain the Owner's risks because this equipment is not included in Facility EMP.
d. Data for existing equipment outside scope of the Project may be inserted in Facility EMP Binders without analysis.
e. Data for existing equipment impacted by scope of the Project should be analyzed and documented similar to the Project's new equipment data as much as possible.

C. Compile operation and maintenance data from Facility EMP analysis and submit **updated** Facility EMP Binders.

3.4 INSTALLATION OF ELECTRICAL WORK

A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' written instructions, comply with NFPA 70 and NECA NEIS 1 for installation of electrical Work on the Project. Consult Architect for resolution of conflicting requirements.

3.5 CLOSEOUT ACTIVITIES

A. Training:

1. **With assistance from factory-authorized service representatives, train** Owner's maintenance personnel on the following topics:

a. How to implement **updated** Facility EMP.

2. **Allow Owner to record training sessions.**

END OF SECTION 260010

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 REFERENCE ORGANIZATIONS

ANSI American National Standards Institute
ASTM American Society for Testing and Materials
EPA Environmental Protection Agency
ETL Electrical Testing Laboratories, Inc.
IEEE Institute of Electrical and Electronics Engineers
IES Illuminating Engineering Society
ISA Instrument Society of America
NBS National Bureau of Standards
NEC National Electric Code
NEMA National Electrical Manufacturers Association
NESC National Electrical Safety Code
NFPA National Fire Protection Association
NRTL Nationally Recognized Testing Laboratory
OBC Ohio Building Code
UL Underwriters Laboratories Inc.

1.02 REGULATORY REQUIREMENTS

A. All work and materials are to conform in every detail to applicable rules and requirements of the Ohio Building Code, the National Electrical Code (NFPA 70), other applicable National Fire Protection Association codes, the National Electrical Safety Code, and present manufacturing standards (including NEMA).

B. All Division 26 work shall be done under the direction of a currently licensed State of Ohio Master Electrician. The electrical work included in all other divisions is the responsibility of the contractor performing the division 26 work unless noted otherwise.

1.03 DESCRIPTION

A. Furnish material, labor, tools, accessories, and equipment to complete and leave ready for operation all electrical systems of this Project as described in these Specifications and as shown on the Drawings.

B. It is the intent that the Electrical Work be complete in every respect. Install Work in compliance with the Latest Enforced Edition of all applicable Codes, Regulations, and Standards, unless otherwise noted. Obtain all permits, licenses, and certifications required by the Code Authority having Jurisdiction.

C. Only a Contractor and craftsmen licensed by the State as required shall install this Electrical Work.

D. Use sufficient journeymen electricians and competent supervisors in execution of this portion of the Work to ensure proper and adequate installation throughout. In the acceptance or rejection

of installed electrical system, no allowance will be made for lack of skill on the part of workers.

E. Shop drawings for the installation of an electrical system shall be submitted and reviewed by the A/E before any electrical system is installed, enlarged, or extended. Under NO circumstances shall any Work be performed prior to receiving shop drawings reviewed by the A/E.

F. Coordinate location of all work and equipment.

G. Work includes, but is not limited to, the following:
1. Alternates.
2. Concrete conduit encasement and pull box encasement.
3. Install HVAC variable speed drive.
4. Electric heating: Wall heaters.
5. Control wiring.
6. Fuel station wiring.
7. Lighting controls.
8. Power systems.
9. Back-up power systems.
    a. Generator.
    b. Automatic transfer switch.
10. Transient voltage surge suppressor.
11. Lighting systems.
12. Telephone/data system.
13. Public address intercom system.
14. Fire alarm system.
15. Carbon monoxide detection system.
16. Site electrical systems: Refer to Section 33 70 00.01.

H. Work Not Included:
1. The Owner shall provide the following work directly or through a separately negotiated Contract:
    a. Telephones and related switching equipment.
    b. Computers and modems.
    c. Security system equipment and wiring.

I. The electrical system shall not be considered complete and acceptable unless, and until, all Code and Governing Agency requirements are satisfied.

J. The bedding and backfill requirements listed in this Section represent a minimum requirement. If Local or State requirements are in excess of listed requirements, such requirements shall supersede.

K. All excavation and backfill work shall comply with requirements of the latest standards of the occupational safety and health administration (OSHA).

L. Provide excavation and backfilling for Electrical Work. Backfill to finish grade or to levels suitable for finish grading and provide finish grading.

M. Coordinate routing of underground lines with the A/E to minimize disruption and damage to trees, shrubs, walks, drives, and other landscape features.

N. Excavation, backfill, surface repair, and traffic control within the public right-of-way shall be in accordance with governing agency rules and regulations. Pay any fee associated with alteration of the roadway.

O. Remove unusable or surplus excavated material from the site. Deposit any usable excavated material where directed by the A/E.

P. Locate and touch existing underground utilities, if any, in the areas of new Work. If utilities are to remain in place, provide adequate means of protection during earthwork operations. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, notify the A/E immediately for instructions before proceeding. Cooperate with Utility Companies and the Owner in keeping services and the facilities in operation.

Q. Excavation damage to, or interruption of service of, any underground utility shall be a liability of the Contractor, whether or not plotted on the Drawings. Promptly repair or replace all damage to any existing utility to the full satisfaction of the Utility Company, the Utility Owner, and the A/E.

R. All existing utility service conduits, wiring, etc., which are uncovered, whether within or beyond the property lines, shall be suitably supported, protected, and maintained in operation, and shall be protected against settlement when excavations are refilled.

S. Coordinate timing of excavations where required by Code Authority having Jurisdiction or where otherwise specified herein.
T. Obtain approval from the A/E for bearing conditions.

U. Contact the A/E to obtain copies of Soils reports, if available. Bidders are strongly urged to visit the site and investigate existing soil conditions themselves.

V. (11) months after Contract Completion, review the excavated areas and add any backfill as required due to settling, etc. Re-seed or re-sod as required.

W. Contractor shall provide seed grass cover to reestablish landscape to existing conditions where disturbed by its Work. This includes replacement of existing plants, shrubs, and related items.

X. Repair and restore plants, shrubs, trees, sodded areas, paving, streets, curbs, and walks to match existing in the area where excavations are made.

Y. Maintain seeded lawns not less than (11) months after Contract Completion and add any backfill as required due to settling, etc. If seeded in non-growing season and not given full (11) months of maintenance, or if not considered acceptable at that time, continue the following growing season until an acceptable lawn is established, as determined by the A/E.

Z. In Drywall, Masonry, or Concrete Wall Construction:
1. Furnish sleeves for conduit, telephone, data, paging, and control wiring, and other electrical items.
2. Option for above ceiling only: Contractor shall omit block(s) where required for penetrations, and shall provide square finished opening. Do not omit blocks under bearing points or in fire rated or smoke rated walls.
3. Contractor shall provide openings through metal building walls and seal watertight.

AA. In precast concrete work, in lieu of sleeves, cut holes after erection of concrete.

BB. Sleeve where electrical work passes exposed through walls, and where any electrical work passes through smoke-rated or fire-rated separations, equipment room walls, or above-grade floors.

CC. If sleeves are not installed in construction, due to fault of the Contractor, holes through masonry or concrete construction shall be core drilled by the Contractor at the Contractor's expense.

DD. Sleeves are not required in floor slabs on grade or in core-drilled openings not requiring water-proofing or fire suppression. Exception: Sleeves are required at core drilling through hollow core pre-cast slabs and through concrete block walls, to facilitate containment of required fire-stopping material.

EE. Sleeving with absolutely watertight seal is required for electrical work passing through exterior walls above grade, and underground foundation walls and other below-grade penetrations into building.

1.04 GUARANTEE

A. Contractor shall guarantee its equipment, workmanship, and materials for a period of (1) year from the date of Contract Completion. Should defects develop within this period, the Contractor shall, at no cost to the Owner, remedy the defects and reimburse the Owner for all damage to other Work caused either by the defects or as a result of the work of correcting the same.

B. Refer also to Division 01 and other Specification Sections that define the starting date of the guarantee period, or that discuss either additional warranty requirements, or extended equipment warranties beyond the standard period.

PART 2 PRODUCTS

2.01 DESIGN BASE MANUFACTURER STANDARD

A. The Drawings and Specifications are based on the specific equipment requirements and configuration for a Design Base Manufacturer. Design coordination of equipment with the building and with other Trades has been made for this specific Model and Manufacturer of equipment. Where several Manufacturers are listed for an item of equipment or material, the first-named shall be considered the Design Base Manufacturer Standard.

B. Consideration will not be given to any other Manufacturer that the Contractor proposes to use, unless the Manufacturer has been approved by the A/E and specifically named in the Contract Documents or Addenda thereto.

2.02 OTHER MANUFACTURERS

A. Any specified Equipment Manufacturer furnished by the Contractor other than the Design Base Manufacturer shall be, in the opinion of the A/E, equivalent in quality, design, features,

performance, arrangement, and appearance to that of the Design Base equipment or material, including any special features or requirements.

B. No consideration will be given to any Manufacturer which the Contractor proposes as an "Approved Equal," unless the Manufacturer has been approved by the A/E during the bid period as provided for in Instructions to Bidders (IB), Paragraph 2.5, and specifically named in the Contract Documents or Addenda thereto.

C. Recognizing that since no two Manufacturers are "identical," whenever the Contractor elects to furnish specified equipment or material manufactured by other than the Design Base Manufacturer, the Contractor shall be responsible for the cost and coordination of all modifications required to accommodate the elected equipment or material, including any Work of other Trades that might be affected. Where changes to other Trades' Work are required, the Contractor shall include the additional costs of all such Work in its bid.

D. Where deemed necessary by the A/E, the Contractor shall, at no additional cost to the Owner, prepare new layouts for these other brands of equipment which may have different dimensional r service requirements from the Design Base Manufacturer Standard. Submit these layouts to the A/E for review.

E. Reimburse the A/E for the cost of any design changes incurred by the A/E in the preparation of revised Drawings or Specifications to accommodate the use of any Manufacturer other than the Design Base Manufacturer.

2.03 ALTERNATIVE MANUFACTURERS

A. Contractor shall submit information, in accordance with Instructions to Bidders (IB), Paragraph 2.5, on any proposed equipment or material that it desires to use as an Approved Equal.

B. If the A/E determines an alternative Manufacturer to be acceptable, it will issue an Addendum adding that Manufacturer to the Specification.

2.04 EQUIPMENT SUITABILITY

A. All equipment provided shall perform as intended. All items listed shall function properly, and as the Manufacturer intended. Install equipment according to the Manufacturer's recommendations. Properly attach equipment to the floor, wall, or structure. Each item of equipment shall be compatible with all other accessories or hook-ups, including controls, wiring, and other equipment that are not furnished by the equipment Manufacturer, but that are required as an accessory or modification, as necessary to achieve its intended function.

2.05 MISCELLANEOUS ACCESSORIES

A. Provide any additional adapters, fittings, trim, structural steel angles, channels, unistrut, brackets, etc., as necessary to securely mount and install all items of equipment specified or shown on the Drawings.

1. All steel installed outside or exposed to moisture shall be hot-dipped galvanized.
2. All miscellaneous brackets, etc. installed inside and within 5 ft. of Salt Barns and Mix Buildings and within 12 ft. of Brine Making and Calcium Chloride areas are to be 316 stainless steel or FRP.

B. These accessories are required even though they may not be shown or detailed on the Drawings.

C. Installation shall be compatible with the building construction on which the item is to be located.

D. Verify the type of construction prior to ordering the equipment item, so that all required accessories are included.

2.06 QUANTITIES

A. Equipment may be referred to in these Specifications, or on the Drawings, as either singular or plural; the Contractor shall verify the exact number of items required to complete its Work.

2.07 BACKFILL

A. Typical backfill conditions:
1. Where bedding is not specified or required by Code: Previously excavated material.
2. Concrete pads and bases: Granular material conforming to Division 02 requirements.

B. Materials:
1. Crushed stone: (ODOT Item 304).
2. Pea gravel: 1/8 in. minimum to 3/4 in. maximum diameter.
3. Sand: Clean, dry, coarse or medium.
4. Washed gravel: 3/4 in. size.
5. Concrete encasement: Material conforming to Division 03 requirements.

C. Materials Prohibited from Being Used for Backfill:
1. Material containing large rocks (over 2 in.), building materials, masonry debris, cinders, rubbish, wood, or other material subject to decay.
2. Any material which may cause damage to cabling, conduit, or duct banks.
3. Frozen earth.

2.08 STANDARD SLEEVES

A. Sleeve material, up to 8 in. diameter: Machine-cut Schedule 40 black steel pipe.

B. Sizing: Sleeves shall be large enough for insulation to be continuous, or for watertight or fire-rated sleeve seals to be installed. Size to allow 1/2 in. minimum clearance all around.

2.09 WATERTIGHT SLEEVE SEALS

A. Oakum Caulking: Thiokol Corp. With lead-pour or elastomeric sealant. Elastomeric sealant shall be 2 component, polysulfide or polyurethane.
1. Other Acceptable Manufacturers: Approved equal by 3M, Calpico, or Hilti.

B. Compression Seals: Thunderline Corp. Linkseal. Stainless steel bolts and nuts. Provide correct size seal, and coordinate with sleeve size.
1. Other Acceptable Manufacturers: Approved equal by Wayne, Michigan, or Calpico.

C. Provide sleeves with waterstop anchor flange at midpoint where penetrating structure at or

below grade.

1. Acceptable Manufacturers: Calpico, 3M, or Hilti.

2.10 FIRE-RATED SLEEVE SEALS

A. ASTM E119 and E814 Silicone RTV foam, UL-approved.

B. The sealant shall be red so they can be easily inspected by building personnel.

2.11 PAINTING OF ELECTRICAL SYSTEMS

A. Refer to Division 9 for painting specifics.

B. Electrical systems shall be painted to match adjacent finishes except for fire alarm conduit which should be painted red.

PART 3 - QUALITY ASSURANCE

A. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the contractor is responsible for all costs involved in integrating the equipment or accessories into the system and the assigned space, and for obtaining the performance from the system into which these items are placed.

B. Manufacturer references used herein are intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply.

C. All materials, shall be listed by and shall bear the label of an approved Nationally Recognized Testing Laboratory (NRTL) as identified by the United States Occupational Safety and Health Administration (OSHA), per the OSHA Nationally Recognized Testing Laboratory Program. If none of the approved electrical testing laboratories has published standards for a particular item, then other national independent testing standards, if available, applicable, and approved by DFD, shall apply and such items shall bear those labels. Where one of the approved electrical testing laboratories has an applicable system listing and label, the entire system, shall be so labeled.

END OF SECTION 260500

SECTION 260511 - EQUIPMENT HOOK-UP AND FINAL CONNECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Coordinate the electrical requirements of equipment with the Supplying Contractor or Manufacturer.

B. Provide plug-in or rough-in and final connection for each piece of equipment requiring power, including, but not limited to, the following:
1. Electric cord reels.
2. Overhead doors
3. Owner furnished equipment.

END OF SECTION 26 05 11

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

A. Provide conductors and cable for secondary feeder and branch circuit wiring, special system wiring, and control wiring.

B. Unless otherwise noted, all conductors shall be enclosed in a continuous, grounded raceway system.

1.2 SUMMARY

A. Section Includes:

1. Copper building wire rated 600 V or less.
2. Aluminum building wire rated 600 V or less.
3. Metal-Insulated cable, Type MI, rated 600 V or less.
4. Fire-alarm wire and cable.
5. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: Indicate type, use, location, and termination locations.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. All line voltage (120 volts and higher) conductors shall be stranded copper, 600 volt insulation, Type THWN or XHHW 75 deg. C., and color-coded as indicated below.

B. Type THHN 90 deg. C. conductors shall be used for all ballasted lighting fixtures.

C. Motor conductors supplied from a variable speed drive shall have XLP insulation rated 1,000 volts (minimum), and shall be suitable for the pulse output signals generated by IGBT devices.

2.2 FLEXIBLE WIRING SYSTEM

A. Contractor has option to use a UL-listed, flexible wiring system in lieu of conduit for lighting circuits only.

2.3 SPECIAL SYSTEM WIRING

A. All wiring shall be as specified above, unless specifically indicated otherwise. Refer to respective applicable Special System Sections for description of required wire or cable.

2.4 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alpha Wire; brand of Belden, Inc.
2. Belden Inc.
3. Cerro Wire LLC.
4. Encore Wire Corporation.
5. General Cable; Prysmian Group North America.
6. Okonite Company (The).
7. Service Wire Co.
8. Southwire Company, LLC.
9. WESCO.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Conductor Insulation:

1. Type RHH and Type RHW-2: Comply with UL 44.
2. Type THHN Comply with UL 83.
3. Type THW: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
4. Type XHHW-2: Comply with UL 44.

2.5 ALUMINUM BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn aluminum current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alpha Wire; brand of Belden, Inc.
2. Belden Inc.
3. Cerro Wire LLC.
4. Encore Wire Corporation.
5. General Cable; Prysmian Group North America.
6. Okonite Company (The).
7. Southwire Company, LLC.
8. WESCO.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Aluminum, complying with ASTM B800 and ASTM B801.

E. Conductor Insulation:

1. Type RHH and Type RHW-2: Comply with UL 44.
2. Type THHN: Comply with UL 83.
3. Type THW: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
4. Type XHHW-2: Comply with UL 44.

2.6 FIRE-ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allied Wire & Cable Inc.

2. CommScope, Inc.
3. Comtran Corporation.
4. Genesis Cable Products; Honeywell International, Inc.
5. PYROTENAX; brand of nVent Electrical plc.
6. Prysmian Cables and Systems; Prysmian Group North America.
7. Radix Wire.
8. Rockbestos-Suprenant Cable Corp.
9. Superior Essex Inc.; subsidiary of LS Corp.
10. West Penn Wire; brand of Belden, Inc.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG Retain "Circuit Integrity Cable" Subparagraph below if use of cable is an option.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

2.7 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

2.4.1 PLUG CONNECTED CABLE

A. Flexible cord for short connection to equipment shall be 600 volt, heat-resistant, rubber insulated portable cable with neoprene jacket, UL Type “ST” on “SRDT.” Cord shall be extra-flexible stranded copper with ground conductor. Provide termination plug as required.

B. Flexible cable is NOT permitted for motor connections.

2.4.2 SPLICES

A. Splices in conductors #10 AWG and smaller wire shall be made with Minnesota Mining and Manufacturing Company insulated “Scotch Locks,” Ideal Company “Wing nut,” or Thomas & Betts Type “PT” connectors, or with mechanically crimped sleeves as manufactured by Thomas

& Betts or Ideal Company, which shall be insulated with pressure-sensitive electrical tape equal to Minnesota Mining and Manufacturing Company “Scotch 33+.”

B. Splices in conductors #8 AWG and larger shall be made with pressure type mechanical connectors and insulated with (2) layers of insulating putty and (2) layers of “Scotch 88” tape.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

1. Material: Copper.
2. Type: One hole with long barrels.
3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders:

1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
2. Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors must be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits:

1. Copper, Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN/THWN-2, single conductors in raceway

B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway. Coordinate "Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground" Paragraph below with Section 260543 "Underground Ducts and Raceways for Electrical Systems."

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway. Coordinate "Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground" Paragraph below with Section 260543 "Underground Ducts and Raceways for Electrical Systems."

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533.13 "Conduits for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 INSTALLATION OF FIRE-ALARM WIRE AND CABLE

A. Comply with NFPA 72.

B. Wiring Method: Install wiring in metal pathway according to Section 280528 "Pathways for Electronic Safety and Security."

1. Install plenum cable in environmental airspaces, including plenum ceilings.
2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system must be installed in a dedicated pathway system.

    a. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.

3. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is permitted.
4. Signaling Line Circuits: Power-limited fire-alarm cables may be installed in the same cable or pathway as signaling line circuits.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring

diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.

F. Risers: Install at least two vertical cable risers to serve the fire-alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent receipt or transmission of signals from other floors or zones.

G. Wiring to Remote Alarm Transmitting Device: 1 inch (25 mm) conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inch (150 mm) of slack.

D. Comply with requirements in Section 284621.11 "Addressable Fire-Alarm Systems" for connecting, terminating, and identifying wires and cables.

3.6 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.8 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grounding and bonding conductors.
2. Grounding and bonding clamps.
3. Grounding and bonding bushings.
4. Grounding and bonding hubs.
5. Grounding and bonding connectors.
6. Intersystem bonding bridge grounding connector.
7. Grounding and bonding busbars.
8. Grounding (earthing) electrodes.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product indicated.

B. Shop Drawings: Plans showing dimensioned locations of grounding features described in "Field Quality Control" Article, including the following:

1. Test wells.
2. Rod electrodes.
3. Ring electrodes.
4. Grounding arrangements and connections for separately derived systems.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. In addition to items specified in Section 260010 "Supplemental Requirements for Electrical," include the following:

    a. Plans showing locations of grounding features described in "Field Quality Control" Article, including the following:

        1) Test wells.
        2) Rod electrodes.
        3) Ring electrodes.
        4) Grounding arrangements and connections for separately derived systems.

    b. Instructions for periodic testing and inspection of grounding features at test wells ring electrodes grounding connections for separately derived systems based on NETA MTS, or NFPA 70B.

        1) Tests must determine if ground-resistance or impedance values remain within specified maximums, and instructions must recommend corrective action if values do not.
        2) Include recommended testing intervals.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

A. Equipment Grounding Conductor:

1. General Characteristics: 600 V, THHN/THWN-2 copper wire or cable, green color, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Isolated Equipment Grounding Conductor:

1. General Characteristics: 600 V, THHN/THWN-2 copper wire or cable, green color with one or more yellow stripes, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. ASTM - Bare Copper Grounding and Bonding Conductor:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ERICO; brand of nVent Electrical plc.
    b. Harger Lightning & Grounding; business of Harger, Inc.

2. Referenced Standards: Complying with one or more of the following:

    a. Soft or Annealed Copper Wire: ASTM B3
    b. Concentric-Lay Stranded Copper Conductor: ASTM B8.
    c. Tin-Coated Soft or Annealed Copper Wire: ASTM B33.

d. 19-Wire Combination Unilay-Stranded Copper Conductor: ASTM B787/B787M.

D. UL KDSH - Protector Grounding Conductor:

1. Description: Conductors intended to be used for grounding primary protector or metallic members of cable sheath in accordance with Chapters 7 and 8 of NFPA 70.

2. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Superior Essex Inc.; subsidiary of LS Corp.

3. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

4. Listing Criteria:

a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

5. Options:

a. Color: Light olive gray or green.

2.2 GROUNDING AND BONDING CLAMPS

A. Description: Clamps suitable for attachment of grounding and bonding conductors to grounding electrodes, pipes, tubing, and rebar. Grounding and bonding clamps specified in this article are also suitable for use with communications applications; see Section 270526 "Grounding and Bonding for Communications Systems," for selection and installation guidelines.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

C. UL KDER and KDSH - Hex-Fitting-Type Pipe and Rod Grounding and Bonding Clamp

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ABB, Electrification Business.
    b. America Fujikura Ltd. (AFL); Fujikura Ltd.
    c. Arlington Industries, Inc.
    d. Cooper B-line; brand of Eaton, Electrical Sector.
    e. Crouse-Hinds; brand of Eaton, Electrical Sector.
    f. ERICO; brand of nVent Electrical plc.
    g. Galvan Industries, Inc.; Electrical Products Division, LLC.
    h. Greaves Corp.; Essex Products Group, Inc.
    i. Harger Lightning & Grounding; business of Harger, Inc.
    j. ILSCO.
    k. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
    l. Panduit Corp.
    m. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.

2. General Characteristics:

    a. Two pieces with zinc-plated stainless steel bolts.
    b. Clamp Material: Silicon bronze
    c. Listed for outdoor use.

D. UL KDER and KDSH - U-Bolt-Type Pipe and Rod Grounding and Bonding Clamp

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ABB, Electrification Business.
    b. America Fujikura Ltd. (AFL); Fujikura Ltd.
    c. Arlington Industries, Inc.
    d. Cooper B-line; brand of Eaton, Electrical Sector.
    e. Crouse-Hinds; brand of Eaton, Electrical Sector.
    f. ERICO; brand of nVent Electrical plc.
    g. Galvan Industries, Inc.; Electrical Products Division, LLC.
    h. Greaves Corp.; Essex Products Group, Inc.
    i. Harger Lightning & Grounding; business of Harger, Inc.
    j. ILSCO.
    k. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
    l. Panduit Corp.
    m. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.

2. General Characteristics:

    a. Clamp Material: .Copper or Copper Alloy
    b. Listed for outdoor use.

E. UL KDER and KDSH - Strap-Type Pipe and Rod Grounding and Bonding Clamp

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    b. Crouse-Hinds; brand of Eaton, Electrical Sector.
    c. ERICO; brand of nVent Electrical plc.
    d. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
    e. Panduit Corp.

2. General Characteristics:

    a. Clamp Material: Copper
    b. Listed for outdoor use.

F. UL KDER - Beam Grounding and Bonding Clamp

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ABB, Electrification Business.
    b. Anderson; brand of Hubbell Utility Solutions; Hubbell Incorporated.
    c. Panduit Corp.
    d. Penn-Union Corp.; subsidiary of Nesco, Inc.

2. General Characteristics: Mechanical-type, terminal, ground wire access from four directions; with dual, tin-plated or silicon bronze bolts.

G. UL KDER - Exothermically Welded Connection

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ABB, Electrification Business.
    b. ALLTEC LLC.
    c. Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated.
    d. Crouse-Hinds; brand of Eaton, Electrical Sector.
    e. ERICO; brand of nVent Electrical plc.
    f. Harger Lightning & Grounding; business of Harger, Inc.

2. General Characteristics: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

H. UL KDER - Raised-Floor Signal Reference Grid Clamp

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ABB, Electrification Business.
    b. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    c. Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated.

d. Cooper B-line; brand of Eaton, Electrical Sector.
e. ERICO; brand of nVent Electrical plc.
f. Harger Lightning & Grounding; business of Harger, Inc.

2. General Characteristics: Mechanical-type, stamped-steel terminal with hex head screw.

2.3 GROUNDING AND BONDING BUSHINGS

A. Description: Bonding bushings connect conduit fittings, tubing fittings, threaded metal conduit, and unthreaded metal conduit to metal boxes and equipment enclosures, and have one or more bonding screws intended to provide electrical continuity between bushing and enclosure. Grounding bushings have provision for connection of bonding or grounding conductor and may or may not also have bonding screws.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

C. UL KDER - Bonding Bushing

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Business.
b. Arlington Industries, Inc.
c. Crouse-Hinds; brand of Eaton, Electrical Sector.
d. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
e. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
f. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.

2. General Characteristics: Threaded bushing with insulated throat.

D. UL KDER - Grounding Bushing:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Business.
b. Arlington Industries, Inc.
c. Crouse-Hinds; brand of Eaton, Electrical Sector.
d. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated.

e. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
f. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.

2. General Characteristics: Threaded bushing with insulated throat and mechanical-type wire terminal.

2.4 GROUNDING AND BONDING HUBS

A. Description: Hubs with certified grounding or bonding locknut.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

C. UL KDER - Grounding and Bonding Hub

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Business.
b. Arlington Industries, Inc.
c. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
d. Crouse-Hinds; brand of Eaton, Electrical Sector.
e. Greaves Corp.; Essex Products Group, Inc.
f. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
g. Penn-Union Corp.; subsidiary of Nesco, Inc.

2. General Characteristics: Insulated, gasketed, watertight hub with mechanical-type wire terminal.

2.5 GROUNDING AND BONDING CONNECTORS

A. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

   a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
   b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

B. UL KDER - Pressure-Type Grounding and Bonding Busbar Cable Connector

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ABB, Electrification Business.
   b. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.

2. General Characteristics: Copper or copper alloy, for compression bonding of one or more conductor directly to copper busbar. Listed for direct burial.

C. UL KDER - Lay-In Lug Mechanical-Type Grounding and Bonding Busbar Terminal

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ABB, Electrification Business.
   b. Chatsworth Products, Inc.
   c. Greaves Corp.; Essex Products Group, Inc.
   d. ILSCO.

2. General Characteristics: Mechanical-type copper rated for direct burial terminal with set screw.

D. UL KDER - Crimped Lug Pressure-Type Grounding and Bonding Busbar Terminal

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ABB, Electrification Business.
   b. Harger Lightning & Grounding; business of Harger, Inc.
   c. ILSCO.

2. General Characteristics: Cast silicon bronze, solderless compression-type wire terminals; with long barrel and two holes spaced on 5/8 or 1 inch (16 or 25 mm) centers for two-bolt connection to busbar.

E. UL KDER - Split-Bolt Service-Post Pressure-Type Grounding and Bonding Busbar Terminal

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Panduit Corp.

2. General Characteristics: Bolts that surround cable and bond to cable under compression when nut is tightened after assembly is screwed into busbar opening.

F. UL KDER - Crimped Pressure-Type Grounding and Bonding Cable Connector

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ABB, Electrification Business.
   b. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
   c. ILSCO.
   d. allG Fabrication (formerly ALT).

2. General Characteristics: Crimp-and-compress connectors that bond to conductor when connector is compressed around conductor.

   a. Copper C and H shaped.

G. UL KDER - Split-Bolt Pressure-Type Grounding and Bonding Cable Connector

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ABB, Electrification Business.
   b. ERICO; brand of nVent Electrical plc.
   c. Greaves Corp.; Essex Products Group, Inc.
   d. allG Fabrication (formerly ALT).

2. General Characteristics: Bolts that surround cable and bond to cable under compression when nut is tightened.

   a. Copper

H. UL KDER - Signal Reference Grid Grounding and Bonding Connector

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ABB, Electrification Business.
   b. Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated.
   c. Cooper B-line; brand of Eaton, Electrical Sector.
   d. ERICO; brand of nVent Electrical plc.
   e. Harger Lightning & Grounding; business of Harger, Inc.

2. General Characteristics: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

2.6 GROUNDING AND BONDING BUSBARS

A. Description: Miscellaneous grounding and bonding device that serves as common connection for multiple grounding and bonding conductors.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

3. Sustainability Characteristics:

a. Refer to Specification SECTION 018113.14 - SUSTAINABLE DESIGN REQUIREMENTS - LEED v4 BD+C for requirements.

C. UL KDER - Equipment Room Grounding and Bonding Busbar:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Chatsworth Products, Inc.
b. Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated.
c. Cooper B-line; brand of Eaton, Electrical Sector.
d. ERICO; brand of nVent Electrical plc.
e. Harger Lightning & Grounding; business of Harger, Inc.
f. Hoffman; brand of nVent Electrical plc.
g. ILSCO.
h. Panduit Corp.
i. allG Fabrication (formerly ALT).

2. General Characteristics:

a. Bus: Rectangular bar of annealed copper.
b. Mounting Stand-Off Insulators: Lexan or PVC.

1) Comply with UL 891 for use in 600 V switchboards, impulse tested at 5000 V.

3. Options:

a. Dimensions: 1/4 by 4 inch (6.3 by 100 mm) in cross section; length as indicated on Drawings.
b. Predrilled Hole Pattern: 9/32 inch (7.14 mm) holes spaced 1-1/8 inch (28 mm) apart.

c. Mounting Hardware: Stand-off brackets that provide 2 inch (50 mm) clearance to access rear of bus. Brackets and bolts must be stainless steel.

D. UL KDER - Rack and Cabinet Bonding Busbar:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Chatsworth Products, Inc.
b. Cooper B-line; brand of Eaton, Electrical Sector.
c. Harger Lightning & Grounding; business of Harger, Inc.
d. Hoffman; brand of nVent Electrical plc.
e. Panduit Corp.

2. General Characteristics:

a. Bus: Rectangular bar of hard-drawn solid copper.

2.7 GROUNDING (EARTHING) ELECTRODES

A. Description: Grounding electrodes include rod electrodes, ring electrodes, metal underground water pipes, metal building frames, concrete-encased electrodes, and pipe electrodes.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

C. UL KDER - Rod Electrode

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Business.
b. Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated.
c. ERICO; brand of nVent Electrical plc.
d. Galvan Industries, Inc.; Electrical Products Division, LLC.
e. Harger Lightning & Grounding; business of Harger, Inc.
f. allG Fabrication (formerly ALT).

2. General Characteristics: Copper-clad; 3/4 inch by 10 ft (19 mm by 3 m).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.

B. Inspect test results of grounding system measured at point of electrical service equipment connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of electrical service equipment only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF BUSBARS

A. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inch (50 mm) minimum from wall, 6 inch (150 mm) above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.3 SELECTION OF GROUNDING AND BONDING CONDUCTORS

A. Conductors: Install solid conductor for 8 AWG and smaller, and stranded conductors for 6 AWG and larger unless otherwise indicated.

B. Custom-Length Insulated Equipment Bonding Jumpers: 6 AWG, 19-strand, Type THHN.

C. Bonding Cable: 28 kcmil, 14 strands of 17 AWG conductor, 1/4 inch (6 mm) in diameter.

D. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.

E. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch (41 mm) wide and 1/16 inch (1.6 mm) thick.

F. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch (41 mm) wide and 1/16 inch (1.6 mm) thick.

G. Underground Grounding Conductors: Install barecopper conductor, 2/0 AWG minimum.

1. Bury at least 30 inch (750 mm) below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inch (300 mm) above duct bank when indicated as part of duct-bank installation.

3.4 SELECTION OF CONNECTORS

A. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.5 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Conductors:

a. Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

2. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
b. Make connections with clean, bare metal at points of contact.
c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
f. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1) Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate adjacent parts.

2) Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3) Use exothermic-welded connectors for outdoor locations; if disconnect-type connection is required, use bolted clamp.

g. Grounding and Bonding for Piping:

1) Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use bolted clamp connector or bolt lug-type connector to pipe flange by using one of lug bolts of flange. Where dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2) Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with bolted connector.
3) Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

h. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
i. Grounding for Steel Building Structure: Install driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 ft (18 m) apart.

3. Electrodes:

a. Ground Rods: Drive rods until tops are 2 inch (50 mm) below finished floor or final grade unless otherwise indicated.

1) Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2) Use exothermic welds for below-grade connections.

b. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least same distance from other grounding electrodes, and connect to service grounding electrode conductor.
c. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and must be at least 12 inch (300 mm) deep, with cover.

1) Install at least one test well for each service unless otherwise indicated. Install at ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

d. Ring Electrode: Install grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around perimeter of building.

1) Install tinned-copper conductor not less than 2/0 AWG for ring electrode and for taps to building steel.
2) Bury ring electrode not less than24 inch (600 mmfrom building's foundation.

e. Concrete-Encased Electrode (Ufer Ground):

1) Fabricate in accordance with NFPA 70; use minimum of 20 ft (6 m) of bare copper conductor not smaller than 4 AWG.

a) If concrete foundation is less than 20 ft (6 m) long, coil excess conductor within base of foundation.
b) Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

2) Fabricate in accordance with NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 ft (6.0 m) long. If reinforcing is in multiple pieces, connect together by usual steel tie wires or exothermic welding to create required length.

4. Grounding at Service:

a. Equipment grounding conductors and grounding electrode conductors must be connected to ground bus. Install main bonding jumper between neutral and ground buses.

5. Grounding Separately Derived Systems:

a. Generator: Install grounding electrode(s) at generator location. Electrode must be connected to equipment grounding conductor and to frame of generator.

6. Grounding Underground Distribution System Components:

a. Duct-Bank Grounding Conductor: Bury 12 inch (300 mm) above duct bank when indicated as part of duct-bank installation.
b. Comply with IEEE C2 grounding requirements.
c. Pad-Mounted Transformers and Switches: Install two ground rods and ring electrode around pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than 2 AWG for ring electrode and for taps to equipment grounding terminals. Bury ring electrode not less than 6 inch (150 mm) from foundation.

7. Equipment Grounding:

a. Install insulated equipment grounding conductors with feeders and branch circuits.
b. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1) Feeders and branch circuits.
2) Lighting circuits.
3) Receptacle circuits.
4) Single-phase motor and appliance branch circuits.
5) Three-phase motor and appliance branch circuits.
6) Flexible raceway runs.
7) Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

c. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
d. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
e. Isolated Grounding Receptacle Circuits: Install insulated equipment grounding conductor connected to receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.
f. Isolated Equipment Enclosure Circuits: For designated equipment supplied by branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.
g. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.
h. Metallic Fences: Comply with requirements of IEEE C2.

1) Grounding Conductor: Bare copper, not less than 8 AWG
2) Gates: Must be bonded to grounding conductor with flexible bonding jumper.
3) Barbed Wire: Strands must be bonded to grounding conductor.

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.
3. Test completed grounding system at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells and at individual ground rods. Make tests at ground rods before conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method in accordance with IEEE Std 81.
    c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to record of tests and observations. Include number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Nonconforming Work:

1. Grounding system will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective components and retest.

C. Collect, assemble, and submit test and inspection reports.

1. Report measured ground resistances that exceed the following values:

    a. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 Ω .
    b. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 Ω
    c. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 Ω
    d. Power Distribution Units or Panelboards Serving Electronic Equipment: **3 Ω**.

3.7 PROTECTION

A. After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel slotted support systems.
2. Conduit and cable support devices.
3. Support for conductors in vertical conduit.
4. Structural steel for fabricated supports and restraints.
5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
6. Fabricated metal equipment support assemblies.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Include construction details, material description, dimensions of individual components, and profiles, and finishes for the following:

1. Hangers. Include product data for components.
2. Slotted support systems.
3. Equipment supports.
4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittals: For hangers and supports for electrical systems.

1. Include design calculations and details of hangers.
2. Include design calculations for seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified structural professional engineer to design hanger and support system.

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame Rating: Class 1.
2. Self-extinguishing according to ASTM D635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32 inch (10 mm) diameter holes at a maximum of 8 inch (200 mm) on center in at least one surface.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Business.
b. Allied Tube & Conduit; Atkore International.
c. CADDY; brand of nVent Electrical plc.
d. Cooper B-line; brand of Eaton, Electrical Sector.
e. Flex-Strut Inc.
f. G-Strut.
g. Gripple Inc.
h. Haydon Corporation.
i. MIRO Industries.
j. Metal Ties Innovation.
k. Rocket Rack; Robroy Industries.
l. Unistrut; Atkore International.
m. Wesanco, Inc.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Material for Channel, Fittings, and Accessories: Galvanized steel. Retain first option in "Channel Width" Subparagraph below to allow Contractor to select size of slotted support system.
4. Channel Width: Selected for applicable load criteria
5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) Hilti, Inc.
      2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) Cooper B-line; brand of Eaton, Electrical Sector.
      2) Empire Industries, Inc.
      3) Hilti, Inc.
      4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325 (Grade A325M).
6. Toggle Bolts: All steel springhead type.

7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 SELECTION

A. Comply with the following standards for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA NEIS 101
2. NECA NEIS 102.
3. NECA NEIS 105.
4. NECA NEIS 111.

B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways specified in Section 260533.13 "Conduits for Electrical Systems."

D. Comply with requirements for boxes specified in Section 260533.16 "Boxes and Covers for Electrical Systems."

E. Provide vibration and seismic controls with hangers and supports in accordance with requirements specified in "Section 260548.16 "Seismic Controls for Electrical Systems."

F. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as scheduled in NECA NEIS 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size must be 1/4 inch (6 mm) in diameter.

G. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps

H. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch (38 mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 INSTALLATION OF SUPPORTS

A. Comply with NECA NEIS 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA NEIS 1, EMTIMC may be supported by openings through structure members, in accordance with NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination must be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inch (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inch (100 mm) thick.
6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M. Submit welding certificates.

END OF SECTION 260529

SECTION 260533.13 - CONDUITS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Duct raceways, elbows.
2. Fittings for conduit, tubing, and cable.
3. Electrically conductive corrosion-resistant compounds for threaded conduit.
4. Solvent cements.

B. Products Installed, but Not Furnished, under This Section:

1. See Section 260553 "Identification for Electrical Systems" for electrical equipment labels.

C. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" for nonmetallic underground conduit with conductors (Type NUCC).
4. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes, and underground utility construction.

1.2 DEFINITIONS

A. Conduit: A structure containing one or more duct raceways.

B. Duct Raceway: A single enclosed raceway for conductors or cable.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Type EMT-S duct raceways and elbows.
2. Type ENT duct raceways and fittings.
3. Type HDPE and Type EPEC duct raceways and fittings.
4. Type ERMC-A and Type ERMC-SS duct raceways, elbows, couplings, and nipples.
5. Type ERMC-S duct raceways, elbows, couplings, and nipples.
6. Type FMC-S and Type FMC-A duct raceways.

7. Type FMT duct raceways.
8. Type IMC duct raceways.
9. Type LFMC duct raceways.
10. Type LFNC duct raceways.
11. Type PVC duct raceways and fittings.
12. Type RTRC-AG duct raceways and fittings.
13. Type RTRC-BG duct raceways and fittings.
14. Fittings for conduit, tubing, and cable.
15. Electrically conductive corrosion-resistant compounds for threaded conduit.
16. Solvent cements.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions:
1. Type EMT-S duct raceways and elbows.
2. Type ENT duct raceways and fittings.
3. Type HDPE and Type EPEC duct raceways and fittings.
4. Type ERMC-A and Type ERMC-SS duct raceways, elbows, couplings, and nipples.
5. Type ERMC-S duct raceways, elbows, couplings, and nipples.
6. Type FMC-S and Type FMC-A duct raceways.
7. Type FMT duct raceways.
8. Type IMC duct raceways.
9. Type LFMC duct raceways.
10. Type LFNC duct raceways.
11. Type PVC duct raceways and fittings.
12. Type RTRC-AG duct raceways and fittings.
13. Type RTRC-BG duct raceways and fittings.
14. Fittings for conduit, tubing, and cable.
15. Electrically conductive corrosion-resistant compounds for threaded conduit.
16. Solvent cements.

1.5 GENERAL

A. Unless otherwise noted, all conductors shall be enclosed in a continuous, grounded, steel conduit or raceway.

B. The conduit system shall be made mechanically tight and electrically continuous throughout. Conduit system shall be grounded at the service entrance.

C. Use galvanized steel conduit. Exception: Conduit exposed outside shall be rigid aluminum. No aluminum conduit is permitted inside or encased in concrete.

D. Schedule 40 PVC and coilable Schedule 80 HDPE conduit is permitted underground with limitations or, under certain conditions, below slabs.

E. Minimum Size: 1/2 in. for control and low voltage wiring only; 3/4 in. for line voltage wiring; 1 in. minimum below slab or underground, except as otherwise indicated.

PART 2 – PRODUCTS

2.1 CONDUIT SYSTEMS

A. Use electrical metallic tubing, intermediate metal conduit, or rigid steel conduit, as specified below:

1. Threaded rigid or intermediate conduit is required where conduit is ANY of the following:

a. 2 1/2 in. or larger.

b. Exposed to physical damage.

c. Exposed within 8 ft. of finished floor.

d. Run in slab or in exterior walls.

e. Run in hazardous locations.

2. Threaded rigid or intermediate conduit is required where vertical drops are made to equipment in open space. The vertical conduit shall be rigidly supported from the equipment, extend a minimum of 10 ft. above floor level, and be not less than 1 in. diameter.

3. Steel thin-wall EMT up through 2 in. diameter may be used elsewhere in interior construction, where rigid or intermediate is not otherwise required.

4. Schedule 40 PVC conduit may be installed below the ground floor slab WITH 24 IN. MINIMUM COVER. PVC conduit shall terminate below the slab and connect to rigid steel or intermediate metal riser conduit.

B. Flexible Steel Conduit: Final connections to motors and equipment subject to vibration or moisture shall be made with 3/4 in. flexible steel conduit, 18 in. to 24 in. long, with PVC jacket, and containing copper phase and ground conductors. Connections between recessed lighting fixtures and junction boxes may be installed using 1/2 in. flexible steel conduit not over 72 in. long.

C. Metallic and nonmetallic surface raceway systems shall be complete with boxes, fittings, elbows, terminations, and all mounting hardware.

2.2 STEEL CONDUIT FITTINGS

A. Rigid or intermediate conduit fittings shall be threaded. EMT conduit fittings shall be compression type only. Conduit bodies shall be malleable iron, threaded for heavy wall conduit and compression type for EMT, with cadmium finish and cadmium-plated sheet steel covers. Provide neoprene cover gaskets for conduit body covers exposed to the weather.

2.3 LIQUID-TIGHT FLEXIBLE METAL CONDUIT (LTFMC)

A. LTFMC may be used in short lengths to provide some vibration isolation. Contractor may use 1/2 in. LTFMC in short lengths (5 ft. maximum) to match equipment hubs on such items as motors, damper operators, limit switches, and similar controls where it is impractical to use 3/4 in. fittings.

2.4 BRIDLE RINGS

A. Provide steel bridle rings for supporting low voltage cable above accessible ceilings.

2.5 CABLE TRAY

A. Basket: UL-listed, 4 in. deep load depth, 12 in. wide, structural wire mesh, with 4-1/2 in. x 4-1/2 in. openings complete with splices, hold down clips, connectors, and single center support hangers.

PART 3 - EXECUTION

3.1 SELECTION OF CONDUITS FOR ELECTRICAL SYSTEMS

B. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of duct raceways. Consult Architect for resolution of conflicting requirements.

C. Special Instructions Regarding HDPE Conduits: Although Article 353 of NFPA 70 permits use of HDPE conduits where encased in concrete aboveground, UL CCN EAZX listing requirements state that HDPE and EPEC underground conduits are intended only for use where direct buried with or without being encased in concrete. Specified Type HDPE and Type EPEC underground conduits are not permitted to be used aboveground on Project.

D. Outdoors:

1. Exposed and Subject to Severe Physical Damage: ERMC.
2. Exposed and Subject to Physical Damage: ERMC

   a. Locations less than 2.5 m (8 ft) above finished floor.
   b.

3. Exposed and Not Subject to Physical Damage: ERMC
4. Concealed Aboveground: IMCEMT].
5. Direct Buried: PVC-40
6. Concrete Encased Not in Trench: PVC-40.
7. Concrete Encased in Trench: PVC-40.
8. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment):LFMC.

E. Indoors:

1. Exposed and Subject to Severe Physical Damage: ERMC. Locations include the following:

    a. Loading docks.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms.

2. Exposed and Subject to Physical Damage: ERMC. Locations include the following:

    a. Locations less than 2.5 m (8 ft) above finished floor.
    b. Stub-ups to above suspended ceilings.

3. Exposed and Not Subject to Physical Damage: IMCEMT
4. Concealed in Ceilings and Interior Walls and Partitions: ERMCIMCEMT
5. Damp or Wet Locations: ERMC
6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

F. Duct Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.

1. ERMC and IMC: Provide threaded-type fittings unless otherwise indicated.

3.2 INSTALLATION OF CONDUITS FOR ELECTRICAL SYSTEMS

G. Comply with manufacturer's published instructions.

H. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Type EMT-A: Article 358 of NFPA 70 and NECA NEIS 102.
2. Type EMT-SS: Article 358 of NFPA 70 and NECA NEIS 101.
3. Type EMT-S: Article 358 of NFPA 70 and NECA NEIS 101.
4. Type ENT: Article 362 of NFPA 70 and NECA NEIS 102.
5. Type HDPE and Type EPEC: Article 353 of NFPA 70 and NECA NEIS 111.
6. Type ERMC-A: Article 344 of NFPA 70 and NECA NEIS 102.
7. Type ERMC-SS: Article 344 of NFPA 70 and NECA NEIS 101.
8. Type ERMC-S: Article 344 of NFPA 70 and NECA NEIS 101.
9. Type FMC-S: Article 348 of NFPA 70 and NECA NEIS 101.
10. Type FMC-A: Article 348 of NFPA 70 and NECA NEIS 102.
11. Type FMT: Article 360 of NFPA 70 and NECA NEIS 101.
12. Type IMC: Article 342 of NFPA 70 and NECA NEIS 101.
13. Type LFMC: Article 350 of NFPA 70 and NECA NEIS 101.
14. Type LFNC: Article 342 of NFPA 70 and NECA NEIS 111.
15. Type PVC: Article 356 of NFPA 70 and NECA NEIS 111.
16. Type RTRC: Article 355 of NFPA 70 and NECA NEIS 111.
17. Expansion Fittings: NEMA FB 2.40.
18. Consult Architect for resolution of conflicting requirements.

I. Special Installation Techniques:

1. General Requirements for Installation of Duct Raceways:

   a. Complete duct raceway installation before starting conductor installation.
   b. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 ft (0.6 m) above finished floor.
   c. Install no more than equivalent of three 90-degree bends in conduit run except for control wiring conduits, for which no more than equivalent of two 90-degree fewer bends are permitted. Support within 12 inch (300 mm) of changes in direction.
   d. Make bends in duct raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
   e. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
   f. Support conduit within 12 inch (300 mm) of enclosures to which attached.
   g. Install duct sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed duct raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install duct sealing fittings in accordance with NFPA 70.
   h. Install devices to seal duct raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of duct raceways at the following points:

      1) Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
      2) Where an underground service duct raceway enters a building or structure.
      3) Conduit extending from interior to exterior of building.
      4) Conduit extending into pressurized duct raceway and equipment.
      5) Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
      6) Where otherwise required by NFPA 70.

   i. Do not install duct raceways or electrical items on "explosion-relief" walls or rotating equipment.
   j. Do not install conduits within 2 inch (50 mm) of the bottom side of a metal deck roof.
   k. Keep duct raceways at least 6 inch (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal duct raceway runs above water and steam piping.
   l. Cut conduit perpendicular to the length. For conduits metric designator 53 (trade size 2) and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
   m. Install pull wires in empty duct raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb (90 kg) tensile strength. Leave at least 12 inch (300 mm) of slack at both ends of pull wire. Cap underground duct raceways designated as spare above grade alongside duct raceways in use.
   n. Install duct raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.

1) Termination fittings with shoulders do not require two locknuts.

o. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to metric designator 35 (trade size 1-1/4) and insulated throat metal bushings on metric designator 41 (trade size 1-1/2) and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

2. Types EMT-A, ERMC-A, and FMC-A: Do not install aluminum duct raceways or fittings in contact with concrete or earth.
3. Types ERMC and IMC:

a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of duct raceway and fittings before making up joints. Follow compound manufacturer's published instructions.

4. Type ERMC-S-PVC:

a. Follow manufacturer's installation instructions for clamping, cutting, threading, bending, and assembly.
b. Provide PVC-coated sealing locknut for exposed male threads transitioning into female NPT threads that do not have sealing sleeves, including transitions from PVC couplings/female adapters to Type ERMC-S-PVC elbows in direct-burial applications. PVC-coated sealing locknuts must not be used in place of conduit hub. PVC-coated sealing locknut must cover exposed threads on Type ERMC-S-PVC duct raceway.
c. Coat field-cut threads on PVC-coated duct raceway with manufacturer-approved corrosion-preventing conductive compound prior to assembly.

5. Types FMC, LFMC, and LFNC:

a. Provide a maximum of 72 inch (1830 mm) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

6. Types PVC, HDPE, and EPEC:

a. Do not install Type PVC, Type HDPE, or Type EPEC conduit where ambient temperature exceeds 122 deg F (50 deg C. Conductor ratings must be limited to 75 deg C except where installed in a trench outside buildings with concrete encasement, where 90 deg C conductors are permitted.
b. Comply with manufacturer's published instructions for solvent welding and fittings.

7. Type RTRC: Do not install Type RTRC conduit where ambient temperature exceeds 230 deg F (110 deg C).

8. Stub-ups to Above Recessed Ceilings:

a. Provide EMT, IMC, or ERMC for duct raceways.

b. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

9. Duct Raceway Terminations at Locations Subject to Moisture or Vibration:

a. Provide insulating bushings to protect conductors, including conductors smaller than 4 AWG. Install insulated throat metal grounding bushings on service conduits.

10. Duct Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.

a. ERMC-S-PVC: Provide only fittings listed for use with this type of conduit. Patch and seal joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Provide sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
b. EMT: Provide set screw or compression, steel fittings. Comply with NEMA FB 2.10.
c. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.

11. Expansion-Joint Fittings:

a. Install in runs of aboveground PVC that are located where environmental temperature change may exceed 30 deg F (17 deg C) and that have straight-run length that exceeds 25 ft (7.6 m). Install in runs of aboveground ERMC and EMT conduit that are located where environmental temperature change may exceed 100 deg F (55 deg C) and that have straight-run length that exceeds 100 ft (30 m).
b. Install type and quantity of fittings that accommodate temperature change listed for the following locations:

1) Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
2) Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
3) Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C temperature change.
4) Attics: 135 deg F (75 deg C) temperature change.

c. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
d. Install expansion fittings at locations where conduits cross building or structure expansion joints.
e. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's published instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

12. Duct Raceways Penetrating Rooms or Walls with Acoustical Requirements: Seal duct raceway openings on both sides of rooms or walls with acoustically rated putty or firestopping.
13. Identification: Provide labels for conduit assemblies, duct raceways, and associated electrical equipment.

J. Interfaces with Other Work:

1. Coordinate with Section 078413 "Penetration Firestopping" for installation of firestopping at penetrations of fire-rated floor and wall assemblies.
2. Coordinate with Section 260529 "Hangers and Supports for Electrical Systems" for installation of conduit hangers and supports.

3.3 PROTECTION

K. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533.13

SECTION 260533.16 - BOXES AND COVERS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metallic outlet boxes, device boxes, rings, and covers.
2. Nonmetallic outlet boxes, device boxes, rings, and covers.
3. Junction boxes and pull boxes.
4. Cover plates for device boxes.
5. Hoods for outlet boxes.

B. Products Installed, but Not Furnished, under This Section:

1. See Section 260553 "Identification for Electrical Systems" for electrical equipment labels.

C. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Metallic outlet boxes, device boxes, rings, and covers.
2. Nonmetallic outlet boxes, device boxes, rings, and covers.
3. Junction boxes and pull boxes.
4. Cover plates for device boxes.
5. Hoods for outlet boxes.

B. Shop Drawings:

1. Shop drawings for floor boxes.

1.3 GENERAL

A. Provide boxes for devices, lighting fixtures, motors and equipment connections, system equipment connections, and special outlets. Provide pullboxes where more than (2) 90 deg. bends are required or if conductors are pulled further than 100 ft.

PART 2 - PRODUCTS

2.1 BOXES

A. All outlet boxes shall be galvanized pressed steel of standard knockout type.

B. Lighting outlet boxes shall be standard 4 in. octagonal, 1 1/2 in. minimum deep boxes with 3/8 in. fixture-mounting stud. Outlet boxes having more than (2) conduits, or when 3/4 in. conduit is used, shall be standard 4 in. square boxes 1 1/2 in. deep or deeper as might be required to accommodate the wiring contained therein.

C. Flush device boxes in masonry walls shall be masonry boxes designed for the purpose, or 4 in. square boxes with raised covers designed for masonry.

D. Wiring device boxes for surface conduit work and those located in potentially damp areas shall be FS Series cast boxes. Exterior exposed boxes shall be weatherproof or airtight with gaskets.

E. Where outlet boxes are cast in concrete slabs, they shall be designed for concrete installation.

F. Flush device boxes in plaster or drywall construction shall be 4 in. square, 2 1/8 in. deep boxes or gangable 2 1/2 in. deep boxes. Shallow 1 1/2 in. deep gangable boxes may be used only in demountable partitions and in other walls too thin for standard depth boxes.

G. Boxes shall be large enough to accommodate the size and number of conduits secured thereto and the size and number of wiring conductors.

H. All fittings, covers, and hardware shall be galvanized steel.

I. Furnish narrow boxes for mounting switches in door frames/mullions.

J. Boxes shall be NEMA type approved for the prevailing environmental conditions.

K. OUTDOOR PULL BOXES

A. Provide grade-mounted, precast polymer concrete, watertight, open bottom, heavy-duty gasketed covers, suitable for occasional non-deliberate heavy vehicle drive-over application, with logo, size as required.

B. Acceptable Manufacturers: Quazite or approved equal by Synertech.

2.2 COVER PLATES FOR DEVICES BOXES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. Listing Criteria: UL CCN QCIT or UL CCN QCMZ; including UL 514D.
3. Wallplate-Securing Screws: Metal with head color to match wallplate finish.

B. UL QCIT or QCMZ - Nonmetallic Cover Plates for Device Boxes:

1. Options:

a. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
b. Wallplate Material: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device. Color: White; CRITICAL OPERATING POWER, Blue; UPS POWER, Orange

2.3 HOODS FOR OUTLET BOXES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. Listing Criteria:

a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.
b. Receptacle, Hood, Cover Plate, Gaskets, and Seals: UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.

3. Mounts to box using fasteners different from wiring device.

4. Additional Characteristics: Marked "Extra-Duty" in accordance with UL 514D.
5. Options:

a. Provides clear, weatherproof, "while-in-use" cover.

PART 3 - EXECUTION

3.1 SELECTION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.

B. Degree of Protection:

1. Outdoors:

a. Type 3R unless otherwise indicated.
b. Locations Exposed to Hosedown: Type 4.
c. Locations Subject to Potential Flooding: Type 6P.
d. Locations Aboveground Where Mechanism Must Operate When Ice Covered: Type 3S.
e. Locations in-Ground or Exposed to Corrosive Agents: Type 4X

f. Locations in-Ground or Exposed to Corrosive Agents Where Mechanism Must Operate When Ice Covered: Type 3SX.

2. Indoors:

a. Type 1 unless otherwise indicated.

3.2 INSTALLATION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Outlet, Device, Pull, and Junction Boxes: Article 314 of NFPA 70.
2. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
2. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
3. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box, whether installed indoors or outdoors.
4. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
5. Locate boxes so that cover or plate will not span different building finishes.
6. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
7. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
8. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
9. Set metal floor boxes level and flush with finished floor surface.
10. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
11. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
12. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
13. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:

a. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.
b. Provide gaskets for wallplates and covers.

14. Identification: Provide labels for boxes and associated electrical equipment.

    a. Identify field-installed conductors, interconnecting wiring, and components.
    b. Provide warning signs.
    c. Label each box with engraved metal or laminated-plastic nameplate.

D. Interfaces with Other Work:

1. Coordinate installation of new products with existing conditions.
2. Coordinate with Section 260573.13 "Short-Circuit Studies" for determining available fault current on input feeder.
3. Coordinate with Section 260573.19 "Arc-Flash Hazard Analysis" for determining arc-flash hazard on input feeder.

3.3 PROTECTION

A. After installation, protect boxes from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260533.16

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type IMC raceways.
2. Type PVC raceways and fittings.
3. Type RTRC-BG raceways and fittings.
4. Fittings for conduit, tubing, and cable.
5. Electrically conductive corrosion-resistant compounds for threaded conduit.
6. Solvent cements.
7. Duct accessories.
8. Handholes and boxes for exterior underground wiring.
9. Duct sealing.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" for nonmetallic underground conduit with conductors (Type NUCC).

1.2 ACTION SUBMITTALS

A. Product Data:

1. Duct-bank materials, including spacers and miscellaneous components.
2. Ducts, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Accessories for, handholes, boxes
4. Underground-line warning tape.

B. Shop Drawings:

1. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

   a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
   b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.

c. Include cover design.
d. Include grounding details.
e. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and other accessories.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

D. Sustainable Design Submittals:

1. Refer to Specification SECTION 018113.14 - SUSTAINABLE DESIGN REQUIREMENTS - LEED v4 BD+C for requirements.

1.3 INFORMATIONAL SUBMITTALS

A. Certificates:

1. For concrete and steel used in precast concrete handholes, as required by ASTM C858.

B. Manufacturers' Published Instructions: Record copy of official installation

C. Source Quality-Control Submittals:

1. Source quality-control reports.

PART 2 - PRODUCTS

2.1 TYPE EPEC RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 651A and UL CCN EAZX.

2.2 TYPE ERMC-S RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 6 and UL CCN DYIX.

B. Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Allied Tube & Conduit; Atkore International.
    b. Calconduit; Atkore International.
    c. Crouse-Hinds; brand of Eaton, Electrical Sector.
    d. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    e. Patriot Aluminum Products, LLC.
    f. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
    g. Topaz Lighting & Electric.
    h. Western Tube; Zekelman Industries.
    i. Wheatland Tube; Zekelman Industries.

2. Exterior Coating: Zinc.
3. Options:

    a. Interior Coating: Zinc with organic top coating.
    b. Minimum Trade Size: Metric designator 21 (trade size 3/4).

2.3 TYPE IMC RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 1242 and UL CCN DYBY.

B. Steel Electrical Intermediate Metal Conduit (IMC):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ABB, Electrification Business.
    b. Allied Tube & Conduit; Atkore International.
    c. Calconduit; Atkore International.
    d. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
    e. Topaz Lighting & Electric.
    f. Western Tube; Zekelman Industries.
    g. Wheatland Tube; Zekelman Industries.

2. Options:

    a. Exterior Coating: Zinc
    b. Interior Coating: Zinc with organic top coating.
    c. Minimum Trade Size: Metric designator 21 (trade size 3/4).
    d. Colors: As indicated on Drawings.

2.4 TYPE PVC RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 651 and UL CCN DZYR.

B. Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ABB, Electrification Business.
   b. Calconduit; Atkore International.
   c. JM Eagle.
   d. NAPCO; Westlake Chemical Corp.
   e. Opti-Com Manufacturing Network, Inc (OMNI).
   f. Topaz Lighting & Electric.

2. Dimensional Specifications: Schedule 40.
3. Options:

   a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
   b. Markings: For use with maximum 90 deg C wire.

C. Type A Rigid PVC Concrete-Encased Conduit (PVC-A) and Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Southern Pipe, Inc.

2. Dimensional Specifications: Type A.
3. Options:

   a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

D. Type EB Rigid PVC Concrete-Encased Underground Conduit (PVC-EB) and Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. JM Eagle.
   b. Southern Pipe, Inc.

2. Dimensional Specifications: Type EB.

2.5 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

B. Metallic Fittings for Type ERMC, Type IMC, Type PVC, Type EPEC, and Type RTRC Raceways:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ABB, Electrification Business.
   b. Appleton; Emerson Electric Co., Automation Solutions.
   c. Crouse-Hinds; brand of Eaton, Electrical Sector.
   d. Konkore Fittings; Atkore International.
   e. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
   f. Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway.
   g. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
   h. Southwire Company, LLC.
   i. Topaz Lighting & Electric.

2. General Characteristics: UL 514B and UL CCN DWTT.
3. Options:

   a. Material: Steel
   b. Coupling Method: Setscrew or compression
   c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
   d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

2.6 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL Subject 2419 and UL CCN FOIZ.

B. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. ABB, Electrification Business.

2.7 SOLVENT CEMENTS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: As recommended by conduit manufacturer in accordance with UL 514B and UL CCN DWTT.

3. Sustainability Characteristics:

    a. Refer to Specification SECTION 018113.14 - SUSTAINABLE DESIGN REQUIREMENTS - LEED v4 BD+C for requirements.

B. Solvent Cements for Type PVC Raceways and Fittings:

2.8 DUCT ACCESSORIES

A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ABB, Electrification Business.
    b. Allied Tube & Conduit; Atkore International.
    c. Cantex Inc.
    d. IPEX USA LLC.
    e. PenCell Plastics; brand of Hubbell Utility Solutions; Hubbell Incorporated.
    f. Underground Devices, Inc.

B. Underground-Line Warning Tape: In accordance with Section 260553 "Identification for Electrical Systems."

2.9 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:

    a. ASTM C858 for design and manufacturing processes.
    b. SCTE 77.

B. Source Quality Control:

1. Precast Concrete Utility Structures: Test and inspect in accordance with ASTM C1037.
2. Polymer Concrete and Nonconcrete Handhole and Pull-Box Prototypes: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests must be for specified tier ratings of products supplied. Testing machine pressure gages must have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

    a. Tests of materials must be performed by independent testing agency.

b. Strength tests of complete boxes and covers must be by independent testing agency or manufacturer. Qualified registered professional engineer must certify tests by manufacturer.

C. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover:

1. Description: Molded of sand, concrete, and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or combination.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armorcast Products Company; brand of Hubbell Utility Solutions; Hubbell Incorporated.
   b. MacLean Highline.
   c. NewBasis.
   d. Oldcastle Infrastructure Inc.; CRH Americas.
   e. Quazite; brand of Hubbell Utility Solutions; Hubbell Incorporated.

3. Configuration: Units must be designed for flush burial and have open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and installed location.

   a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
   b. Cover Legend: Molded lettering, "ELECTRIC"

5. Conduit Entrance Provisions: Conduit-terminating fittings must mate with entering ducts for secure, fixed installation in enclosure wall.
6. Handholes 12 inch wide by 24 inch long (300 mm wide by 600 mm long) <Insert dimensions> and larger must have factory-installed inserts for cable racks and pulling-in irons.

D. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover:

1. Description: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armorcast Products Company; brand of Hubbell Utility Solutions; Hubbell Incorporated.
   b. NewBasis.
   c. Oldcastle Infrastructure Inc.; CRH Americas.
   d. Quazite; brand of Hubbell Utility Solutions; Hubbell Incorporated.

3. Configuration: Units must be designed for flush burial and have openbottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.

5. Handholes 12 inch wide by 24 inch long (300 mm wide by 600 mm long) and larger must have factory-installed inserts for cable racks and pulling-in irons.

E. Fiberglass Handholes and Boxes:

1. Description: Molded of fiberglass-reinforced polyester resin, with covers made of polymer concrete
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. MacLean Highline.
b. Nordic Fiberglass, Inc.
c. Oldcastle Infrastructure Inc.; CRH Americas.
d. Quazite; brand of Hubbell Utility Solutions; Hubbell Incorporated.

3. Configuration: Units must be designed for flush burial and have open
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.

5. Cover Legend: Molded lettering, "ELECTRIC".
6. Handholes 12 inch wide by 24 inch long (300 mm wide by 600 mm long) and larger must have factory-installed inserts for cable racks and pulling-in irons.

2.10 DUCT SEALING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB, Electrification Business.
2. American Polywater Corporation.
3. CommScope, Inc.
4. Gardner Bender.
5. Ideal Industries, Inc.
6. NSi Industries LLC.
7. TE Connectivity Ltd.

B. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Compound must be capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduit, conduit and duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals. Duct sealing compound must be removable without damaging ducts or cables.

C. Inflatable Duct-Sealing System: Wraparound inflatable bladder that seals ducts that are empty or containing conductors against air and water infiltration. System is suitable for use in steel, plastic, or concrete ducts and penetrations.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of duct, duct bank, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in field. Notify Architect if there is conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.

3.2 SELECTION OF UNDERGROUND DUCTS

A. Duct for Electrical Feeders: PVC-40concrete encased unless otherwise indicated.

B. Duct for Electrical Branch Circuits: PVC-40, direct buried unless otherwise indicated.

C. Underground Ducts Crossing Paved Paths Walks and Driveways: PVC-40direct buried or encased in reinforced concrete as indicated.

D. Stub-ups: Concrete encased, PVC-40.

3.3 SELECTION OF UNDERGROUND ENCLOSURES

A. Handholes and Boxes:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete, AASHTO HB 17, **H-10** structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: **Precast concrete, AASHTO HB 17, H-10** structural load rating.
3. Units in Sidewalk and Similar Applications with Safety Factor for Nondeliberate Loading by Vehicles: **Precast concrete, AASHTO HB 17, H-10** structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: **Fiberglass-reinforced polyester resin**, structurally tested in accordance with SCTE 77 with 3000 lbf (13 345 N) vertical loading.
5. Cover design load must not exceed load rating of handhole or box.

3.4 EARTHWORK

A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Restore area immediately after backfilling is completedorafter construction vehicle traffic in immediate area is complete.

C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."

E. Cut and patch existing pavement in path of underground duct, duct bank, and underground structures in accordance with "Cutting and Patching" Article in Section 017300 "Execution."

3.5 INSTALLATION OF DUCTS AND DUCT BANKS

A. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA TCB 2 for installation of underground ducts and duct banks.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

1. Where indicated on Drawings, install duct, spacers, and accessories into duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
2. Steel raceway, bends, and fittings in single duct run or duct bank must be of same type.
3. Slope: Pitch duct minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from high point between two manholes to drain in both directions.
4. Expansion and Deflection Fittings: Install expansion and deflection fitting in each duct in area of disturbed earth adjacent to manhole or handhole.
5. Install expansion fitting near center of straight line duct with calculated expansion of more than 3/4 inch (19 mm).
6. Curves and Bends:

    a. Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with minimum radius of 48 inch (1200 mm), both horizontally and vertically, at other locations unless otherwise indicated.
    b. Field bending must be in accordance with NFPA 70 minimum radii requirements, except bends over 45 degrees must be made with minimum radius of 48 inch (1200 mm). Use only equipment specifically designed for material and size involved. Use PVC heating bender for bending PVC conduit.
    c. Duct must have maximum of 180 degrees of bends between pull points.

7. Joints: Use solvent-cemented joints in nonmetallic duct and fittings and make watertight in accordance with manufacturer's published instructions. Stagger couplings so those of adjacent duct do not lie in same plane. Couple steel conduits to ducts with adapters

designed for this purpose, and encase coupling with minimum 3 inch (75 mm) of concrete for minimum of 12 inch (300 mm) on each side of coupling.

a. Install insulated grounding bushings on steel raceway terminations that are less than 12 inch (300 mm) below grade or floor level and do not terminate in hubs.

8. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing duct will not be subject to environmental temperatures above 104 deg F (40 deg C). Where environmental temperatures are calculated to rise above 104 deg F (40 deg C), and anywhere duct crosses above underground steam line, install insulation blankets listed for direct burial to isolate duct bank from steam line to maintain maximum environmental temperature of 104 deg F (40 deg C).
9. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inch (250 mm) o.c. for 5 inch (125 mm) duct, and vary proportionately for other duct sizes.

a. Begin change from regular spacing to end-bell spacing 10 ft (3 m) from end bell, without reducing duct slope and without forming trap in line.
b. Grout end bells into structure walls from both sides to provide watertight entrances.

10. Duct Terminators for Entrances to Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inch (150 mm) o.c. for 4 inch (100 mm) duct, and vary proportionately for other duct sizes.

a. Begin change from regular spacing to terminator spacing 10 ft (3 m) from terminator, without reducing duct line slope and without forming trap in line.

11. Building Wall Penetrations: Make transition from underground duct to steel raceway at least 10 ft (3 m) outside building wall, without reducing duct line slope away from building and without forming trap in line. Use fittings manufactured for transition to steel raceway type installed. Install steel raceway penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
12. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15 psig (1.03 MPa) hydrostatic pressure.
13. Pulling Cord: Install 200 lbf (1000 N) test nylon cord in empty ducts.
14. Concrete-Encased Ducts and Duct Bank:

a. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes 6 inch (150 mm) or less in nominal diameter.
b. Width: Excavate trench **3 inch (75 mm)** wider than duct on each side.
c. Depth: Install so top of duct envelope is at least 24 inch (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inch (750 mm) below finished grade in deliberate traffic paths for vehicles unless otherwise indicated. Install so top of duct envelope is below local frost line.
d. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.

e. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 ft (6 m) of duct. Place spacers within 24 inch (600 mm) of duct ends. Stagger spacers approximately 6 inch (150 mm) between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

f. Minimum Space between Ducts: 3 inch (75 mm) between edge of duct and exterior envelope wall, 2 inch (50 mm) between ducts for like services, and 4 inch (100 mm) between power and communications ducts.

g. Stub-ups to Outdoor Equipment: Extend concrete-encased steel raceway horizontally minimum of 60 inch (1500 mm) from edge of equipment base.

1) Stub-ups must be minimum 4 inch (100 mm) above finished floor and minimum 3 inch (75 mm) from conduit side to edge of slab.

h. Stub-ups to Indoor Equipment: Extend concrete-encased steel raceway horizontally minimum of 60 inch (1500 mm) from edge of wall. Install insulated grounding bushings on terminations at equipment.

1) Stub-ups must be minimum 4 inch (100 mm) above finished floor and no less than 3 inch (75 mm) from conduit side to edge of slab.

i. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

j. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

k. Concrete Cover: Install minimum of 3 inch (75 mm) of concrete cover between edge of duct to exterior envelope wall, 2 inch (50 mm) between duct of like services, and 4 inch (100 mm) between power and communications ducts.

l. Place minimum 6 inch (150 mm) of engineered fill above concrete encasement of duct.

m. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

15. Direct-Buried Duct and Duct Bank:

a. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inch (150 mm) in nominal diameter.

b. Width: Excavate trench 3 inch (75 mm) wider than duct on each side.

c. Depth: Install top of duct at least 36 inch (900 mm) below finished grade unless otherwise indicated.

d. Set elevation of top of duct bank below frost line.
e. Place minimum 3 inch (75 mm) of sand as bed for duct. Place sand to minimum of 6 inch (150 mm) above top level of duct.
f. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
g. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 ft (6 m) of duct. Place spacers within 24 inch (600 mm) of duct ends. Stagger spacers approximately 6 inch (150 mm) between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
h. Install duct with minimum of 3 inch (75 mm) between ducts for like services and 6 inch (150 mm) between power and communications duct.
i. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inch (100 mm) over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.

16. Underground-Line Warning Tape: Bury nonconducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inch (300 mm) above concrete-encased duct and duct banks. Align tape parallel to and within 3 inch (75 mm) of centerline of duct bank. Provide additional warning tape for each 12 inch (300 mm) increment of duct-bank width over nominal 18 inch (450 mm). Space additional tapes 12 inch (300 mm) apart, horizontally across width of ducts.
17. Ground ducts and duct banks in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 INSTALLATION OF CONCRETE HANDHOLES, AND BOXES

A. Reference Standards:

1. Precast Concrete Handholes: Comply with ASTM C891 unless otherwise indicated.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

1. Precast Concrete Handholes:

a. Install units level and plumb and with orientation and depth coordinated with connecting duct to minimize bends and deflections required for proper entrances.
b. Unless otherwise indicated, support units on level bed of crushed stone or gravel graded from 1 inch (25 mm) sieve to No. 4 (4.75 mm) sieve and compacted to same density as adjacent undisturbed earth.

c. Field-cut openings for conduits in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

2. Elevations:

a. Manhole Roof: Install with rooftop at least 15 inch (375 mm) below finished grade.
b. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch (25 mm) above finished grade.
c. Install handholes with bottom below frost line, below grade.
d. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
e. Where indicated, cast handhole cover frame integrally with handhole structure.

3. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

4. Waterproofing: Apply waterproofing to exterior surfaces of and handholes after concrete has cured at least three days.
5. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
6. Ground handholes, and boxes in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Reference Standards:
1. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.
2. Unless otherwise indicated, support units on level bed of crushed stone or gravel, graded from 1/2 inch (12.5 mm) sieve to No. 4 (4.75 mm) sieve and compacted to same density as adjacent undisturbed earth.
3. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
4. Install handholes and boxes with bottom below frost line, below grade.
5. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

6. Field cut openings for duct in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
7. For enclosures installed in asphalt paving and and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour concrete ring encircling, and in contact with enclosure entry, and with top surface screeded to top of box cover frame. Bottom of ring must rest on compacted earth

    a. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with troweled finish.
    b. Dimensions: 10 inch wide by 12 inch deep (250 mm wide by 300 mm deep)

8. Ground handholes and boxes in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

B. Field tests and inspections must be witnessed by Architect

C. Tests and Inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide minimum 12 inch (300 mm) long mandrel equal to duct size minus 1/4 inch (6 mm). If obstructions are indicated, remove obstructions and retest.
3. Test and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

D. Nonconforming Work:

1. Underground ducts, raceways, and structures will be considered defective if they do not pass tests and inspections.
2. Correct deficiencies and retest as specified above to demonstrate compliance.

E. Assemble and submit test and inspection reports.

END OF SECTION 260543

SECTION 260548 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Restraints - rigid type.
3. Restraints - cable type.
4. Restraint accessories.
5. Post-Installed concrete anchors.
6. Concrete inserts.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Include rated load capacity for each seismic-restraint device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic restraint component used.
3. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by an agency acceptable to authorities having jurisdiction.
4. Annotate to indicate application of each product submitted and compliance with requirements.
5. Product Listing, Preapproval, and Evaluation Documentation: an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage qualified structural professional engineer to design seismic control system in accordance with criteria specified in Section 260010 "Supplemental Requirements for Electrical" and Section 260011 "Facility Performance Requirements for Electrical."

B. Seismic Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: an agency acceptable to authorities having jurisdiction.

C. Consequential Damage: Provide additional seismic restraints for suspended electrical components or anchorage of floor-, roof-, or wall-mounted components so that failure of a non-essential or essential component will not cause failure of any other essential building component.

D. Fire/Smoke Resistance: Seismic restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

E. Component Supports:

1. Load ratings, features, and applications of reinforcement components must be based on testing standards of a nationally recognized testing agency.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:.

1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.
3. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
4. Surface Pattern: Smooth, ribbed, or waffle pattern.
5. Infused nonwoven cotton or synthetic fibers.
6. Load-bearing metal plates adhered to pads.
7. Sandwich-Core Material: Resilient

a. Surface Pattern: Smooth, ribbed, or waffle pattern.
b. Infused nonwoven cotton or synthetic fibers.

2.3 RESTRAINTS - RIGID TYPE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CADDY; brand of nVent Electrical plc.
2. California Dynamics Corporation.
3. Cooper B-line; brand of Eaton, Electrical Sector.
4. Hilti, Inc.
5. Isolation Technology, Inc.
6. TOLCO Incorporated.
7. Unistrut; Atkore International.
8. VMC GROUP.

B. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.4 RESTRAINTS - CABLE TYPE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CADDY; brand of nVent Electrical plc.
2. Cooper B-line; brand of Eaton, Electrical Sector.
3. Gripple Inc.
4. Loos & Co. Inc.
5. VMC GROUP.

B. Seismic-Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.

C. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. Cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.5 RESTRAINT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CADDY; brand of nVent Electrical plc.
2. Cooper B-line; brand of Eaton, Electrical Sector.
3. Hilti, Inc.
4. Loos & Co. Inc.

5. Mason Industries, Inc.
6. TOLCO Incorporated.
7. Unistrut; Atkore International.

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.6 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Cooper B-line; brand of Eaton, Electrical Sector.
   b. Hilti, Inc.
   c. Mason Industries, Inc.
   d. Powers Fasteners.
   e. Unistrut; Atkore International.

2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Provide post-installed concrete anchors that have been prequalified for use in seismic and wind-load applications.

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

C. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp (7.46 kW) that is not vibration isolated.

1. Undercut expansion anchors are permitted.

2.7 CONCRETE INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper B-line; brand of Eaton, Electrical Sector.
2. Hilti, Inc.
3. Mason Industries, Inc.
4. Powers Fasteners.
5. Unistrut; Atkore International.

B. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC446 testing.

C. Comply with MSS SP-58.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry static and seismic loads within specified loading limits.

3.3 INSTALLATION OF SEISMIC-RESTRAINT DEVICES

A. Provide seismic restraint devices for systems and equipment where indicated in Equipment Schedules or Seismic and Wind-Load Controls Schedule, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

1. Install equipment and devices to withstand the effects of earthquake motions

B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

C. Installation of seismic restraints must not cause any stresses, misalignment, or change of position of equipment or conduits.

D. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

E. Raceway, Cable, Wireway, Cable Tray, and Busway Support and Hanger Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
3. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
4. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

F. Install cables so they do not bend across edges of adjacent equipment or building structure.

G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

I. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors must be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque using a torque wrench.
5. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

A. Field tests must be witnessed by Architect. Coordinate "Tests and Inspections" Paragraph below with "Qualifications" and "Field Quality Control" articles in Section 260010 "Supplemental Requirements for Electrical."

B. Tests and Inspections:
   1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
   2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
   3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
   4. Test no fewer than **four** of each type and size of installed anchors and fasteners selected by Architect.
   5. Test to 90 percent of rated proof load of device.

C. Nonconforming Work:

   1. Seismic controls will be considered defective if they do not pass tests and inspections.
   2. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

END OF SECTION 260548

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Labels.
2. Bands and tubes.
3. Tapes and stencils.
4. Tags.
5. Signs.
6. Cable ties.
7. Miscellaneous identification products.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: For each piece of electrical equipment and electrical system components to be index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

1.3 GENERAL

A. Identify each piece of electrical equipment, such as switchboard, automatic transfer switch, disconnects, starters, power and lighting panels, and auxiliary systems, on the front cover or trim with its designated name or number/letter shown on the Drawings and with the voltage available within the panel and the source from where it is fed. Identify panelboards in finished areas on the inside cover.

B. Install laminated plastic nameplates for equipment. Identification shall be as indicated on the following examples:

PANEL A

208Y/120 volt, 3 phase, 4 wire

From SWBD MDP

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Seton “Setmark” or approved equal by Brady, MSI, or Calpico.

2.2 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1 and IEEE C2.

B. Comply with 29 CFR 1910.144 for color identification of hazards; 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs and tags; and the following:

1. Fire-protection and fire-alarm equipment, including raceways, must be finished, painted, or suitably marked safety red.
2. Ceiling-mounted hangers, supports, cable trays, and raceways must be finished, painted, or suitably marked safety yellow where less than 7.7 ft (2.3 m) above finished floor.

C. Signs, labels, and tags required for personnel safety must comply with the following standards:

1. Safety Colors: NEMA Z535.1.
2. Facility Safety Signs: NEMA Z535.2.
3. Safety Symbols: NEMA Z535.3.
4. Product Safety Signs and Labels: NEMA Z535.4.
5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.

D. Comply with NFPA 70E and Section 260573.19 "Arc-Flash Hazard Analysis" requirements for arc-flash warning labels.

E. Comply with NEC Article 708

F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, must comply with UL 969.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces

2.3 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 1000 V or Less:

1. Black letters on orange field
2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.

1. Color must be factory applied or field applied for sizes larger than 8 AWG if authorities having jurisdiction permit.
2. Colors for 208Y/120 V Circuits:

   a. Phase A: Black.
   b. Phase B: Red.
   c. Phase C: Blue.

3. Colors for 480Y/277 V Circuits:

   a. Phase A: Brown.
   b. Phase B: Orange.
   c. Phase C: Yellow.

4. Color for Neutral: White
5. Color for Equipment Grounds: Bare copper
6. Colors for Isolated Grounds: Green with two or more yellow stripes.

C. Warning Label Colors:

1. Identify system voltage with black letters on orange background.

D. Warning labels and signs must include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 3 FEET MINIMUM."

E. Uninterruptable Power Supply (UPS)

1. Black letter on orange field

F. Equipment Identification Labels:

1. Black letters on white field.

2.4 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

C. Self-Adhesive Wraparound Labels: Preprinted, 3 mil (0.08 mm) thick, polyester flexible label with acrylic pressure-sensitive adhesive.

1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over legend. Labels sized such that clear shield overlaps entire printed legend.
2. Marker for Labels:

a. Permanent, waterproof, black ink marker recommended by tag manufacturer.
b. Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Polyester, thermal, transfer-printed, 3 mil (0.08 mm) thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
1. Minimum Nominal Size:

a. 1-1/2 by 6 inch (37 by 150 mm) for raceway and conductors.
b. 3-1/2 by 5 inch (76 by 127 mm) for equipment.
c. As required by authorities having jurisdiction.

2.5 BANDS AND TUBES

A. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inch (50 mm) long, with diameters sized to suit diameters and that stay in place by gripping action.

B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at maximum of 200 deg F (93 deg C). Comply with UL 224.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2.6 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
a. Panduit Corp.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mil (0.08 mm) thick by 1 to 2 inch (25 to 50 mm) wide; compounded for outdoor use.

C. Tape and Stencil: 4 inch (100 mm) wide black stripes on 10 inch (250 mm) centers placed diagonally over orange background and are 12 inch (300 mm) wide. Stop stripes at legends.

D. Floor Marking Tape: 2 inch (50 mm) wide, 5 mil (0.125 mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

E. Underground-Line Warning Tape:

1. Tape:

   a. Recommended by manufacturer for method of installation and suitable to identify and locate underground electrical and communications utility lines.
   b. Printing on tape must be permanent and may not be damaged by burial operations.
   c. Tape material and ink must be chemically inert and not be subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

2. Color and Printing:

   a. Comply with APWA Uniform Color Code using NEMA Z535.1 safety colors.
   b. Inscriptions for Red Tapes: **"CAUTION BURIED ELECTRIC LINE BELOW"**<**Insert inscription**>.
   c. Inscriptions for Orange Tapes: **"CAUTION BURIED CATV LINE BELOW""CAUTION BURIED TELEPHONE LINE BELOW" "CAUTION BURIED FIBER OPTIC LINE BELOW" "CAUTION BURIED COMMUNICATION LINE BELOW"** <**Insert inscription**>.

3. Tape Type I

   a. Pigmented polyolefin, bright colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.
   b. Width: 3 inch (75 mm).
   c. Thickness: 4 mil (0.1 mm).
   d. Weight: 18.5 lb/1000 sq. ft (9.0 kg/100 sq. m).
   e. Tensile in accordance with ASTM D882: 30 lbf (133.4 N) and 2500 psi (17.2 MPa).

4. Tape Type ID

   a. Detectable three-layer laminate, consisting of printed pigmented polyolefin film, solid aluminum-foil core, and clear protective film that allows inspection of continuity of conductive core; bright colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.
   b. Width: 3 inch (75 mm).
   c. Overall Thickness: 5 mil (0.125 mm).
   d. Foil Core Thickness: 0.35 mil (8.9 ?m).
   e. Weight: 28 lb/1000 sq. ft (13.7 kg/100 sq. m).
   f. Tensile in accordance with ASTM D882: 70 lbf (311.3 N) and 4600 psi (31.7 MPa).

F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height must be 1 inch (25 mm).

2.7 TAGS

A. Write-on Tags:
1. Polyester Tags: 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment.
2. Marker for Tags:
   a. Permanent, waterproof, black ink marker recommended by tag manufacturer.
   b. Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.8 SIGNS

A. Baked-Enamel Signs:
1. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4 inch (6.4 mm) grommets in corners for mounting.
3. Nominal Size: 7 by 10 inch (180 by 250 mm).

B. Metal-Backed Butyrate Signs:
1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396 inch (1 mm) galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
2. 1/4 inch (6.4 mm) grommets in corners for mounting.
3. Nominal Size: 10 by 14 inch (250 by 360 mm).

C. Laminated Acrylic or Melamine Plastic Signs:
1. Engraved legend.
2. Thickness:
   a. For signs up to 20 sq. inch (129 sq. cm), minimum 1/16 inch (1.6 mm) thick.
   b. For signs larger than 20 sq. inch (129 sq. cm), 1/8 inch (3.2 mm) thick.
   c. Engraved legend with black letters on white face
   d. Punched or drilled for mechanical fasteners with 1/4 inch (6.4 mm) grommets in corners for mounting.
   e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.9 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C) in accordance with ASTM D638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black, except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C) in accordance with ASTM D638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C) in accordance with ASTM D638: 7000 psi (48.2 MPa).
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: Black.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.

2.11 EQUIPMENT IDENTIFICATION

A. Laminated plastic nameplates, sized for minimum 1/4 in. high white letters or numbers engraved into a black background, Gothic style.

B. “Dymo” or similar tape type labels shall NOT be used.

C. Type written panelboard schedules shall be included and installed inside panelboard covers.

D. Identify the covers of each junction and pull box with self-adhesive vinyl labels indicating the circuit numbers which are concealed within.

E. Provide labels for electrical conduits after painting is complete.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

G. System Identification for Raceways and Cables under 1000 V: Identification must completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

I. Emergency Operating Instruction Signs: Install instruction signs with white legend on red background with minimum 3/8 inch (10 mm) high letters for emergency instructions at equipment used for power transfer

J. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from floor.

K. Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and system voltage. System legends must be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."
4. ”COPS”

L. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to location and substrate.

M. Snap-Around Labels: Secure tight to surface at location with high visibility and accessibility.

N. Self-Adhesive Wraparound Labels: Secure tight to surface at location with high visibility and accessibility.

O. Self-Adhesive Labels:

1. Install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide single line of text with 1/2 inch (13 mm) high letters on 1-1/2 inch (38 mm) high label; where two lines of text are required, use labels 2 inch (50 mm) high.

P. Snap-Around Color-Coding Bands: Secure tight to surface at location with high visibility and accessibility.

Q. Heat-Shrink, Preprinted Tubes: Secure tight to surface at location with high visibility and accessibility.

R. Marker Tapes: Secure tight to surface at location with high visibility and accessibility.

S. Self-Adhesive Vinyl Tape: Secure tight to surface at location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for minimum distance of 6 inch (150 mm) where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

T. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

U. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's instructions.

V. Underground Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inch (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in common trench **or concrete** envelope exceeds 16 inch (400 mm) overall.
2. Limit use of underground-line warning tape to direct-buried cables.
3. Install underground-line warning tape for direct-buried cables and cables in raceways.

W. Write-on Tags:

1. Place in location with high visibility and accessibility.
2. Secure using general-purpose cable ties.

X. Baked-Enamel Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
2. Unless otherwise indicated, provide single line of text with 1/2 inch (13 mm) high letters on minimum 1-1/2 inch (38 mm) high sign; where two lines of text are required, use signs minimum 2 inch (50 mm) high.

Y. Metal-Backed Butyrate Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
2. Unless otherwise indicated, provide single line of text with 1/2 inch (13 mm) high letters on 1-1/2 inch (38 mm) high sign; where two lines of text are required, use labels 2 inch (50 mm) high.

Z. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
2. Unless otherwise indicated, provide single line of text with 1/2 inch (13 mm) high letters on 1-1/2 inch (38 mm) high sign; where two lines of text are required, use labels 2 inch (50 mm) high.

AA. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Accessible Raceways and Mineral Insulatrd Cables, 1000 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft (15 m) maximum intervals in straight runs, and at 25 ft (7.6 m) maximum intervals in congested areas.

D. Accessible Fittings for Raceways and Cables within Buildings: Identify cover of junction and pull box of the following systems with self-adhesive labels containing wiring system legend and system voltage. System legends must be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."
4. ”COPS”

5. Retain "Power-Circuit Conductor Identification, 1000 V or Less" Paragraph below if color-coding of power and lighting conductors for phase- or voltage-level identification is required to comply with authorities having jurisdiction or special Project requirements. If retaining, coordinate with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and revise to indicate extent of color-coding required. For existing buildings, indicate whether requirements apply to both old and new wiring or to new wiring only. Below applies only to phase conductors. Color-coding of grounded and grounding conductors must be conducted in accordance with NFPA 70. Verify that Owner does not require another color code. Specify that colors for factory-assembled cable, such as MC and AC, match colors listed below.

E. Power-Circuit Conductor Identification, 1000 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft (15 m) maximum intervals in straight runs, and at 25 ft (7.6 m) maximum intervals in congested areas.

F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with conductor or cable designation, origin, and destination.

G. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with conductor designation.

H. Conductors to Be Extended in Future: Attach marker tape to conductors and list source.

I. Auxiliary Electrical Systems Conductor Identification: Marker tapeSelf-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

J. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

K. Workspace Indication: Apply floor marking tape or tape and stencil to finished surfaces. Show working clearances in direction of access to live parts. Workspace must comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

L. Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.

M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels

1. Apply to exterior of door, cover, or other access.
2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

   a. Power-transfer switches.
   b. Controls with external control power connections.

N. Arc Flash Warning Labeling: Self-adhesive labels.

O. Operating Instruction Signs: Self-adhesive labels

P. Emergency Operating Instruction Signs: Self-adhesive labelswith white legend on red background with minimum 3/8 inch (10 mm) high letters for emergency instructions at equipment used for power transfer Coordinate "Equipment Identification Labels" Paragraph below with electrical Sections. Delete items not in Project.

Q. Equipment Identification Labels:

1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
2. Outdoor Equipment: Laminated acrylic or melamine sign

END OF SECTION 260553

SECTION 260573.13 - SHORT-CIRCUIT STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Computer-based, fault-current study to determine minimum interrupting capacity of circuit protective devices.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 260573.16 "Coordination Studies" for overcurrent protective device coordination studies.
4. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash studies.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For power system analysis software to be used for studies.

B. Short-Circuit Study Report:

1. Submit the following after approval of system protective devices submittals. Submittals must be in digital form.

a. Short-circuit study input data, including completed computer program input data sheets.
b. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
c. Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.4 QUALITY ASSURANCE

A. Study must be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms must comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CGI CYME.
2. EDSA Micro Corporation.
3. ESA Inc.
4. ETAP - Digital Twin Platform.
5. EasyPower, LLC (formerly ESA Inc.).
6. Power Analytics, Corporation.
7. SKM Systems Analysis, Inc.

B. Comply with IEEE 399 and IEEE 551.

C. Analytical features of power systems analysis software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

D. Computer software program must be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kVA and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, and panelboard designations and ratings.
6. Derating factors and environmental conditions.

7. Any revisions to electrical equipment required by study.

D. Comments and recommendations for system improvements or revisions in written document, separate from one-line diagram.

E. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
3. For 600 V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

F. Short-Circuit Study Input Data:

1. One-line diagram of system being studied.
2. Power sources available.
3. Manufacturer, model, and interrupting rating of protective devices.
4. Conductors.
5. Transformer data.

G. Short-Circuit Study Output Reports:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

   a. Voltage.
   b. Calculated fault-current magnitude and angle.
   c. Fault-point X/R ratio.
   d. Equivalent impedance.

2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

   a. Voltage.
   b. Calculated symmetrical fault-current magnitude and angle.
   c. Fault-point X/R ratio.
   d. Calculated asymmetrical fault currents:

      1) Based on fault-point X/R ratio.
      2) Based on calculated symmetrical value multiplied by 1.6.
      3) Based on calculated symmetrical value multiplied by 2.7.

3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.
    b. Calculated symmetrical fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. No AC Decrement (NACD) ratio.
    e. Equivalent impedance.
    f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
    g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

PART 3 - EXECUTION

3.1 POWER SYSTEM DATA

A. Obtain data necessary for conduct of study.

B. Gather and tabulate required input data to support short-circuit study. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to amount of detail that is required to be acquired in field. Field data gathering must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:

3.2 SHORT-CIRCUIT STUDY

A. Perform study following general study procedures contained in IEEE 399.

B. Calculate short-circuit currents according to IEEE 551.

C. Base study on device characteristics supplied by device manufacturer.

D. Extent of electrical power system to be studied is indicated on Drawings.

E. Begin short-circuit current analysis at service, extending down to system overcurrent protective devices as follows:

    1. To normal system low-voltage load buses where fault current is 5 kA or less.
    2. Exclude equipment supplied by single transformer smaller than 75 kVA.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. Include ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement to address asymmetrical requirements of interrupting equipment.

H. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.

I. Include in report identification of protective device applied outside its capacity.

END OF SECTION 260573.13

SECTION 260573.16 - COORDINATION STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 260573.13 "Short-Circuit Studies" for fault-current studies.
4. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash studies.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For power system analysis software to be used for studies.

B. Coordination Study Report:

1. Submit the following after approval of system protective devices submittals. Submittals **must** be in digital form.

   a. Coordination-study input data, including completed computer program input data sheets.
   b. Study and equipment evaluation reports.
   c. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
   d. Revised one-line diagram, reflecting field investigation results and results of coordination study.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.4 QUALITY ASSURANCE

A. Studies must be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms must comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

1.5 REGULATORY AGENCY APPROVALS

A. Submittals for coordination study requiring approval by authorities having jurisdiction must be signed and sealed by qualified electrical professional engineer responsible for their preparation.

B. Submittals for coordination study require action by Architect prior to submitting for approval by authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CGI CYME.
2. EDSA Micro Corporation.
3. ESA Inc.
4. ETAP - Digital Twin Platform.
5. EasyPower, LLC (formerly ESA Inc.).
6. Power Analytics, Corporation.
7. SKM Systems Analysis, Inc.

B. Comply with IEEE 242 and IEEE 399.

C. Analytical features of device coordination study computer software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

D. Computer software program must be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program must report device settings and ratings of overcurrent protective devices and must demonstrate selective coordination by computer-generated, time-current coordination plots.

2.2 COORDINATION STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kVA and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations.
6. Revisions to electrical equipment required by study.
7. Study Input Data: As described in "Power System Data" Article.

a. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

D. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in field. Use manufacturer's data sheets for recording recommended setting of overcurrent protective devices when available.

a. Phase and Ground Relays:

1) Device tag.
2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
3) Recommendations on improved relaying systems, if applicable.

b. Circuit Breakers:

1) Adjustable pickups and time delays (long time, short time, and ground).
2) Adjustable time-current characteristic.
3) Adjustable instantaneous pickup.
4) Recommendations on improved trip systems, if applicable.

c. Fuses: Show current rating, voltage, and class.

E. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for switching schemes and for emergency periods where power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying portion of system covered.

2. Terminate device characteristic curves at point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
3. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:

    a. Power utility's overcurrent protective device.
    b. Medium-voltage equipment overcurrent relays.
    c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
    d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
    e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
    f. Cables and conductors damage curves.
    g. Ground-fault protective devices.
    h. Motor-starting characteristics and motor damage points.
    i. Generator short-circuit decrement curve and generator damage point.
    j. Largest feeder circuit breaker in each motor-control center and panelboard.

5. Maintain selectivity for tripping currents caused by overloads.
6. Provide adequate time margins between device characteristics such that selective operation is achieved.
7. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Obtain data necessary for conduct of overcurrent protective device study.

1. Verify completeness of data supplied in one-line diagram on Drawings. Call discrepancies to Architect's attention.
2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.

B. Gather and tabulate required input data to support coordination study. List below is guide. Comply with recommendations in IEEE 551 for amount of detail required to be acquired in

field. Field data gathering must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:

3.3 COORDINATION STUDY

A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.

B. Comply with IEEE 399 for general study procedures.

C. Base study on device characteristics supplied by device manufacturer.

D. Extent of electrical power system to be studied is indicated on Drawings.

E. Begin analysis at service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 5 kA or less.
2. Exclude equipment supplied by single transformer smaller than 75 kVA.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. Transformer Primary Overcurrent Protective Devices:

1. Device must not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings must protect transformers according to IEEE C57.12.00, for fault currents.

H. Motor Protection:

1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
2. Select protection for motors served at voltages more than 600 V according to IEEE 620.

I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands maximum short-circuit current for time equivalent to tripping time of primary relay protection or total clearing time of fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

J. Generator Protection: Select protection according to manufacturer's instructions and to IEEE 242.

K. Include ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.

L. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.

M. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Include in report identification of protective device applied outside its capacity.

3.4 LOAD-FLOW AND VOLTAGE-DROP STUDY

A. Perform load-flow and voltage-drop study to determine steady-state loading profile of system. Analyze power system performance two times as follows:

1. Determine load flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
2. Determine load flow and voltage drop based on 80 percent of design capacity of load buses.
3. Prepare load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.5 FIELD ADJUSTING

A. Adjust relay and protective device settings according to recommended settings provided by coordination study. Field adjustments must be completed by engineering service division of equipment manufacturer under "Startup and Acceptance Testing" contract portion.

B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

C. Testing and adjusting must be by qualified low-voltage electrical testing and inspecting agency.

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for adjustable overcurrent protective devices.

END OF SECTION 260573.16

SECTION 260573.19 - ARC-FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Computer-based, arc-flash study to determine arc-flash hazard distance and incident energy to which personnel could be exposed during work on or near electrical equipment.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 260573.13 "Short-Circuit Studies" for fault-current studies.
4. Section 260573.16 "Coordination Studies" for overcurrent protective device coordination studies.

1.2 DEFINITIONS

A. p.u.: Per unit. The reference unit, established as a calculating convenience, for expressing all power system electrical parameters on a common reference base.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For power system analysis software to be used for studies.

B. Study Submittals:

1. Submit the following after approval of system protective devices submittals. Submittals must be in digital form:

a. Arc-flash study input data, including completed computer program input data sheets.
b. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

c. Revised one-line diagram, reflecting field investigation results and results of arc-flash study.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.5 QUALITY ASSURANCE

A. Study must be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms must comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

1.6 REGULATORY AGENCY APPROVALS

A. Submittals for arc-flash hazard analysis requiring approval by authorities having jurisdiction must be signed and sealed by qualified electrical professional engineer responsible for their preparation.

B. Submittals for arc-flash hazard analysis require action by Architect prior to submitting for approval by authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CGI CYME.
2. EDSA Micro Corporation.
3. ESA Inc.
4. ETAP - Digital Twin Platform.
5. EasyPower, LLC (formerly ESA Inc.).
6. Power Analytics, Corporation.
7. SKM Systems Analysis, Inc.

B. Comply with IEEE 1584 and NFPA 70E.

C. Analytical features of device coordination study computer software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kVA and voltage ratings, including derating factors and environmental conditions.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

F. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."

G. Arc-Flash Study Output Reports:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in report:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

H. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Restricted approach boundary.
6. Limited approach boundary.
7. Working distance.
8. Incident energy.
9. Hazard risk category.
10. Recommendations for arc-flash energy reduction.

I. Fault study input data, case descriptions, and fault-current calculations including definition of terms and guide for interpretation of computer printout.

2.3 ARC-FLASH WARNING LABELS

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce 3.5 by 5 inch (76 by 127 mm) self-adhesive equipment label for each work location included in analysis.

B. Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard analysis:

1. Location designation.
2. Nominal voltage.
3. Protection boundaries.

   a. Arc-flash boundary.
   b. Restricted approach boundary.
   c. Limited approach boundary.

4. Arc flash PPE category.
5. Required minimum arc rating of PPE in Cal/cm squared.
6. Available incident energy.
7. Working distance.
8. Engineering report number, revision number, and issue date.

C. Labels must be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Preparatory Studies: Perform Short-Circuit and Protective Device Coordination studies prior to starting Arc-Flash Hazard Analysis or obtain results from another source.

1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."

C. Calculate maximum and minimum contributions of fault-current size.

1. Maximum calculation must assume maximum contribution from utility and must assume motors to be operating under full-load conditions.
2. Calculate arc-flash energy at 85 percent of maximum short-circuit current according to IEEE 1584 recommendations.
3. Calculate arc-flash energy at 38 percent of maximum short-circuit current according to NFPA 70E recommendations.
4. Calculate arc-flash energy with utility contribution at minimum and assume no motor contribution.

D. Calculate arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.

E. Include medium- and low-voltage equipment locations, except equipment fed from transformers smaller than 75 kVA.

F. Calculate limited, restricted, and prohibited approach boundaries for each location.

G. Incident energy calculations must consider accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations must take into account changing current contributions, as sources are interrupted or decremented with time. Fault contribution from motors and generators must be decremented as follows:

1. Fault contribution from induction motors must not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators must be decayed to match actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 p.u. to 3 p.u. after 10 cycles).

H. Arc-flash energy must generally be reported for maximum of line or load side of circuit breaker. However, arc-flash computation must be performed and reported for both line and load side of circuit breaker as follows:

1. When circuit breaker is in separate enclosure.
2. When line terminals of circuit breaker are separate from work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

A. Obtain data necessary for conduct of arc-flash hazard analysis.

1. Verify completeness of data supplied on one-line diagram on Drawings. Call discrepancies to Architect's attention.

2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.

3.4 LABELING

A. Apply **one** arc-flash label on front cover of each section of equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in study. Base arc-flash label data on highest values calculated at each location.

B. Each piece of equipment listed below not fed by single transformer smaller than 75 kVA must have arc-flash label applied to it:

1. Low-voltage switchgear
2. Switchboards.
3. Panelboards.
4. Low voltage transformers.
5. Safety switches.
6. Control panels.

C. Note on record Drawings location of equipment where personnel could be exposed to arc-flash hazard during their work.

1. Indicate arc-flash energy.
2. Indicate protection level required.

3.5 APPLICATION OF WARNING LABELS

A. Install arc-flash warning labels under direct supervision and control of qualified electrical professional engineer.

END OF SECTION 260573.19

SECTION 260702 – GAS DETECTION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Gas Detection Systems
   2. Control Panel
   3. Sensor Stations

B. Related Requirements:

   1. Section 230923 “Direct Digital Control (DDC) System for HVAC”

1.2 ACTION SUBMITTALS

A. Product Data

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates

PART 2 - PRODUCTS

2.1 GAS DETECTION SYSTEMS

A. Supply and install as shown on drawings an ACME CEL Series Multipoint & Multigas Centralized Detection and Control System consisting of the following: NEMA 12 central monitoring panels with status lights, double-pole double-throw fan relays, CO sensors and NO2 sensors. Panels and remote sensors/transmitters shall be by the same manufacturer.

B. Refer to the drawings for location of the monitoring panels and sensors. Number of panels and sensors is as indicated on the drawings.

C. The contractor is responsible for providing a complete and operable system including all hardware, material, wiring, etc. All interlocking wiring with mechanical equipment is the responsibility of the contractor.

D. Refer to specification section 23 09 33 for complete sequence of operation for interlocking requirements with makeup air units and exhaust fans.

E. The location and number of sensors shown on the drawings are to be considered a minimum requirement. If the manufacturer recommends more sensors to be located/installed it is the

responsibility of the contractor to provide and install the recommended number of sensors required by the manufacturer.

F. All wiring to be in conduit.

2.1 CONTROL PANEL

A. The system shall use an addressable RS485 communication protocol. Each sensor shall be sequentially polled by the Control Panel. Sensor data shall be acquired and stored in the Control Panel memory.

B. The ACME CEL Series Multipoint System shall use only a common 4-wire 14 gauge communication link between the Control Panel and the local sensor stations.

C. The Control Panel shall have an LED display with an indicating light for each sensor location. This light shall blink slowly for low-level indication, blink quickly for high-level indication and be solid ON for alarm level indication. A liquid-crystal alphanumeric 4-line display shall provide PPM levels for each sensor station, shall indicate the gas being sampled at that location and its alarm status.

D. The Control Panel shall have a keypad for programming purposes and the programming shall be password protected.

E. The system shall have all of its components, including the controller, RS-485 communication module and relay outputs boards in a single enclosure. Multiple enclosures requiring inter-wiring are not acceptable.

F. The equipment shall be CSA and/or ETL certified.

G. "ON - OFF": The Control Panel shall incorporate the necessary logic circuits to operate the exhaust/supply fans and the motorized dampers for fresh air and/or exhaust according to the specified logic of ventilation. For example, if the equipment operated by the 100 PPM CO contacts does not reduce the CO level below this value within 30 minutes (3 to 60 minutes adjustable), the Control Panel shall go on visual and audible alarm and also provide a contact for remote alarm indication or supervision.

H. CONSTRUCTION: The CEL Control Panel shall be of solid ventilated 16 gauge steel construction. All electronic components shall be behind a locked door. There shall be no accessible switches or knobs on front of panel (except for override if specified). All electrical connections should be made to clearly identified terminals.

I. SELF-CHECKING: Integrity of the system shall be under constant checking. Should a remote station not confirm a response, a fault condition will be displayed at the Control Panel with indication of faulty station location. A common alarm shall be locked in.

J. TIME DELAY: The Control Panel shall include a time delay of approximately 30 minutes scheduled between the time a High Level is detected and the time visual display on unit cover or panel, audible alarm and closure of alarm contacts. This time delay is introduced in order to avoid nuisance alarms produced by short temporary conditions. The time delay also allows the ventilation equipment, previously started at a lower gas level below alarm conditions, a reasonable length of time to reverse the gas trend.

K. Control Panel shall be capable of monitoring up to 20 sensors and controlling up to six ventilation zones (outputs signals). Each sensor shall be capable of controlling the activity of a specific zone, all zones or any combination of zones.

2.2 SENSOR STATIONS

A. The wall or column mounted metal or PVC gasketed enclosure with vandalproof cover screws or a lockable clasp and shall not have any parts accessible from outside.

2.3 RESPONSE

A. The local reaction time of the remote stations shall be in the order of a few minutes therefore avoiding unnecessary start-stops of ventilation equipment every time a car happens to stop in the vicinity of the sensor.

B. The sensor's response to ambient conditions shall be interpreted by the detection circuitry according to selected levels. Information is converted for transmittal to Control Panel at scanning time.

C. CO Sensor/Transmitter stations shall have LED's for visual indication of "Power-On", and an LED bar graph indicating concentration levels.

D. Removing or disconnecting a local sensor station from the system shall not affect its operation as long as the "daisy-chain" connection to the other sensor stations is maintained.

E. There shall be no maintenance required except for periodic simple calibration checks performed by introducing a known gas mixture into the sensor and verifying or adjusting the electronic response at the sensor location.

F. CO Metal Oxide Semiconductor (MOS) sensors shall have a life expectancy of 5 years. NO2 and other Electrochemical Cell sensors shall have a life expectancy of two years.

2.4 OPTIONS

A. Provide on Control Panel selector switches with pilot lights to manually override all of the fans controlled by the system.

B. Provide in CEL Control Panel a battery back-up to maintain the system in operation during a power failure. A compact rechargeable battery shall be used because of the reduced power requirement of the CEL system.

C. Provide a Remote Alarm Station furnished with Audible/Visual alarm with silencing button.

D. Provide a 4-20 ma or 0-10V DC analog output signal based on the highest condition or on the average of conditions detected.

E. After complete installation, a manufacturer's representative shall check the installation before the system is started. A written report shall be submitted to the engineers, contractor & owner.

2.5 ACCEPTABLE MANUFACTURERS

A. Provide acceptable equipment as manufactured and provided by Macuro, Toxalert, or Brasch.

PART 3 – EXECUTION

3.1 INSTALLATIONS

A. Wiring: The interconnections between the Control Panel and Sensors shall be made by a required number of branches consisting of 4 conductor 14 gauge wires. Each branch shall support a total length of 800ft and a maximum of eight (8) sensors. For CO remote sensor stations must be mounted vertically according to the arrow on the sensor. Heights between 4 ft. (1.20 m) and 6 ft. (1.80 m) are usual. For NO2 (Diesel Fumes): remote sensor stations must be mounted vertically according to the arrow on the sensor. Install NO2 sensors at heights between 1 foot and 18 inches below the ceiling.

B. CEL systems should be energized at all times. Supply 120/1/60 - 15A from dedicated circuit. It should be impossible to disconnect power to a CEL system in order to service other equipment.

C. All equipment shall be interconnected at the factory and shipped factory calibrated after a 7-dayoperational test. The logic of the system shall be factory tested by simulated field conditions as specified. A report shall be furnished with the equipment.

D. All electrical connections shall be made by the contractor according to diagrams shown on drawings furnished with the equipment by the manufacturer. Use 4-wire coded cable from station to station, maintaining color code. All wiring is low voltage (24V). All wiring to be in conduit.

END OF SECTION 260702

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Lighting contactors.
2. Occupancy sensors.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings:

1. Show installation details for the following:

   a. Occupancy sensors.
   b. Vacancy sensors.

2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

C. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's warranties.

1.4 WARRANTY

A. Special Extended Warranty: Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, devices that fail to perform as specified within extended warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of lighting control software.
b. Faulty operation of lighting control devices.

2. Extended Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LIGHTING CONTACTOR

A. Electrically operated, mechanically held, heavy duty plated contacts, ampere and pole capacity as shown on the Drawings, 120 volt coil, interrupting capacity equal to 150% of rating, NEMA 1 enclosure. Refer to Drawings for load voltage. Provide 2 wire control module accessory #47 as required to interface with programmable time clock (photocell).

2.2 WALL-MOUNTED MULTI-TECHNOLOGY PASSIVE INFRARED/ULTRASONIC OCCUPANCY SENSORS WITH MANUAL OVERRIDE

A. Wall-mounted, UL-listed, self-contained, with (1) ultrasonic transmitter, (1) ultrasonic receiving transducer, sensitivity adjustment, adjustable 30 second to 30 minute time-delay OFF, power pack relay, 120 volt, and full 5 year warranty.

2.3 CEILING-MOUNTED MULTI-TECHNOLOGY PASSIVE INFRARED/ULTRASONIC OCCUPANCY SENSORS WITH MANUAL OVERRIDE

A. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit. Unit shall be UL-listed, self-contained, with (1) ultrasonic transmitter, (1) ultrasonic receiving transducer, sensitivity adjustment, adjustable 30 second to 30 minute time-delay OFF, power pack relay, 120 volt, and full 5 year warranty.

PART 3 - EXECUTION

3.1 INSTALLATION OF SENSORS

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.

3.2 INSTALLATION OF CONTACTORS

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 INSTALLATION OF WIRING

A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).

B. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's instructions.

C. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring in accordance with Section 260553 "Identification for Electrical Systems.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Field tests must be witnessed by Tenant and authorities having jurisdiction.

B. Coordinate "Tests and Inspections" Paragraph below with "Qualifications" and "Field Quality Control" articles in Section 260010 "Supplemental Requirements for Electrical."

C. Tests and Inspections:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Nonconforming Work:

1. Lighting control devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Prepare test and inspection reports.

F. Manufacturer Services:

1. Engage factory-authorized service representative to support and supervise field tests and inspections.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.7 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software support for two years.

2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Verify upgrading software includes operating system and new or revised licenses for using software.

a. Upgrade Notice: No fewer than 3**0** days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3. Upgrade Reports: Prepare written report after each update, documenting upgrades installed.

END OF SECTION 260923

SECTION 262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution, dry-type transformers with nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Transformer working clearances, anchoring, torque values, and insulation-resistance testing.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB, Electrification Business.
2. Acme Electric; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
3. Dongan Electric Manufacturing Company.
4. Eaton.
5. Federal Pacific.
6. Hammond Power Solutions Inc.
7. Jefferson Electric, Inc.
8. Lincoln Electric Products Co., Inc.
9. MGM Transformer Company.
10. Mag-Tran; a division of Quality Transformer & Electronics.
11. Marcus Transformer LTD.
12. Micron Industries Corporation.
13. Mirus International Inc.
14. Powersmiths International Corp.; Socomec Group.
15. Prolec GE; A Xignux and General Electric Company Joint Venture.
16. Rex Power Magnetics.
17. Siemens Industry, Inc., Energy Management Division.
18. SolaHD; Emerson Electric Co., Automation Solutions.
19. Square D; Schneider Electric USA.
20. TEMCo Transformers.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60 Hz service.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. Transformers Rated 15 kVA and Larger:

1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by qualified electrical testing laboratory recognized by authorities having jurisdiction.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70, and list and label as complying with UL 1561.

B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

1. One leg per phase.

C. Coils: Continuous windings without splices except for taps.

1. Coil Material Copper.
2. Internal Coil Connections: Brazed or pressure type.
3. Terminal Connections:Welded

D. Encapsulation: Transformers smaller than 30 kVA must have core and coils completely resin encapsulated.

E. Enclosure: Ventilated.

1. Core and coil must be encapsulated within resin compound to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
3. Wiring Compartment: Sized for conduit entry and wiring installation.
4. Environmental Protection:

a. Indoor: UL 50E, Type 2.
b. Outdoor: UL 50E, Type 3R.

F. Taps for Transformers 3 kVA and Smaller: One 5 percent tap above normal full capacity.

G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

I. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.

J. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.

K. Grounding: Provide ground-bar kit or ground bar installed on inside of transformer enclosure.

L. Wall Brackets: Manufacturer's standard brackets

2.4 IDENTIFICATION

A. Nameplates:

1. Engraved, laminated-acrylic or melamine plastic signs for distribution transformers, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."
2. Self-adhesive label for distribution transformers. Self-adhesive labels are specified in Section 260553 "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for transformers.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's published instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5 Ω at location of transformer.

E. Environment: Enclosures must be rated for environment in which they are located. Covers for UL 50E, Type 4X enclosures may not cause accessibility problems.

3.2 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer

1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
2. Brace wall-mounted transformers as specified in Section 260548.16 "Seismic Controls for Electrical Systems."

B. Construct concrete bases and anchor floor-mounted transformers in accordance with manufacturer's published instructions, seismic requirements applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

C. Secure transformer to concrete base in accordance with manufacturer's published instructions.

D. Secure covers to enclosure and tighten bolts to manufacturer-recommended torques to reduce noise generation.

E. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Provide flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

3.4 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by Architect**.** Coordinate "Tests and Inspections" Paragraph below with "Qualifications" and "Field Quality Control" Articles in Section 260010 "Supplemental Requirements for Electrical."

B. Tests and Inspections:

1. Small (Up to 167 kVA Single-Phase or 500 kVA Three-Phase) Dry-Type Transformer Field Tests:

a. Visual and Mechanical Inspection.

1) Inspect physical and mechanical condition.
2) Inspect anchorage, alignment, and grounding.
3) Verify that resilient mounts are free and that shipping brackets have been removed.
4) Verify that unit is clean.
5) Perform specific inspections and mechanical tests recommended by manufacturer.
6) Verify that as-left tap connections are as specified.
7) Verify presence of surge arresters and that their ratings are as specified.

b. Electrical Tests:

1) Measure resistance at windings, taps, and bolted connections.
2) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: value of index may not be less than 1.0.
3) Perform turns-ratio tests at tap positions. Test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
4) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

C. Test Labeling: On completion of satisfactory testing of units, attach dated and signed "Satisfactory Test" label to tested components.

D. Nonconforming Work:

1. Transformer will be considered defective if it does not pass tests and inspections.
2. Remove and replace units that do not pass tests or inspections and retest as specified above.

E. Assemble and submit test and inspection reports.

3.5 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262213

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Switchboards.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Switchboards.
2. Overcurrent protective devices.
3. Surge protection devices.
4. Groud-fault protection devices.
5. Accessories.
6. Other components.
7. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than UL 50E, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.
7. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

10. Include diagram and details of proposed mimic bus.
11. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Field Quality-Control Submittals:

1. Field Quality-Control Reports:

a. Test procedures used.
b. Test results that comply with requirements.
c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Handling, storing, and providing temporary heat.
2. Mounting accessories and anchoring devices.
3. Testing and adjusting overcurrent protective devices.

B. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: Furnish to Owner spare parts, for repairing switchboards, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:

1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.
2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to switchboards, that are packaged with

protective covering for storage on-site and identified with labels describing contents. Include the following:

1. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.
2. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

1.6 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed switchboard perform in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that switchboard performs in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: Three years from date of Substantial Completion; full coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: Five years from date of Substantial Completion; full coverage for materials that failed because of transient voltage surges only, free on board origin, freight prepaid.

1.7 DESCRIPTION

A. Provide fusible switchboard with main and branch fusible switches as shown on the drawings.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHBOARD

A. Switchboard: Code gauge steel with welded steel base, factory tested, factory assembled, fully bussed.

B. Customer Metering: Provide a multi-function, high accuracy, digital power metering instrumentation module equipped with LED display. The power metering module shall provide simultaneous measurements for current, voltage, and power parameters. Power meter shall be Siemens type 9200 or approved equal with a communications port for connection to energy management network.

C. Bussing: Tin plated copper, copper ground bus, and 50,000 amp. minimum RMS fault current rating.

D. Branch Switches:

1. Fusible switches shall be quick-make, quick-break type, voidable interlock, with rejection-type fuses and operating handle.

2. Refer to Drawings for bus ampacity, switch rating, fuse sizes and types, special wiring, and construction.

E. Bolted Pressure Switches:

1. Unless otherwise noted, furnish fusible, bolted pressure switch for any switch unit rated 800 amps. or greater.

2. Acceptable Manufacturers: Pringle, Kelek, or Bolt Loc.

F. Future Space: Provide space for future switches as shown on the Drawings. Make provisions for an additional future section.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NECA 400 and NEMA PB 2.1.

1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
3. Protect from moisture, dust, dirt, and debris during storage and installation.
4. Install temporary heating during storage per manufacturer's instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to NECA 400 and NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches (50-mm) above concrete base after switchboard is anchored in place.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to switchboards.
6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices, surge protection devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

H. Install spare-fuse cabinet.

I. Comply with NECA 1.

3.3 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.

B. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

C. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.

D. Support and secure conductors within the switchboard according to NFPA 70.

E. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.

E. Tests and Inspections:

1. Acceptance Testing:

   a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
   b. Test continuity of each circuit.

2. Test ground-fault protection of equipment for service equipment per NFPA 70.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
5. Perform the following infrared scan tests and inspections, and prepare reports:

   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front and rear panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.

c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. Switchboard will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Power panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Disconnecting and overcurrent protective devices.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. GFEP: Ground-fault equipment protection.

B. VPR: Voltage protection rating.

C. ATS: Acceptance testing specification.

D. GFCI: Ground-fault circuit interrupter

E. MCCB: Molded-case circuit breaker.

F. SPD: Surge protective device.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Power panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Disconnecting and overcurrent protective devices.
4. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
5. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.
7. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include Internet link for electronic access to downloadable PDF of coordination curves.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards.

B. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Recommended procedures for installing panelboards.
2. Recommended torque settings for bolted connections on panelboards.
3. Recommended temperature range for energizing panelboards.

C. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to panelboards, that are packaged with protective covering for storage on-site and identified with labels describing contents

1.7 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed panelboards perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that panelboards perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.
1. Extended-Warranty Period: Five years from date of Substantial Completion;

1.8 DESCRIPTION

A. Provide factory-assembled panelboards having main lugs or main breaker and branch breakers as shown on the Drawings.

B. Provide GFI, shunt-trip, under voltage trip, and HACR rated and HID rated circuit breakers as indicated by the Panel Schedule(s) or required for the load being served.

PART 2 - PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

A. Dead front, steel cabinet, baked enamel finish, concealed hinges, flush lock, typed circuit directory, copper bussing, separate ground and neutral bars, lugs and adapters suitable for feeder sizes (CU/AL), bolt on thermal magnetic circuit breakers, tripped circuit indicator, 20 amp switching breaker rating, lock-on straps as required.

B. Minimum interrupting capacity shall be 22,000 amps RMS.

C. Furnish integral transient voltage surge suppressor with status indicator lights and a rated-for- minimum-peak surge current of 80,000 amps per mode.

D. Furnish bolt-on breakers. For all air conditioning, compressor, and similar motor loads, furnish Type HACR breakers.

E. Size (up to 400 amps): 20 in. wide x 5 3/4 in. deep; 40 in. wide for double tub panel(s).

F. For double tub panels, furnish feed-through lugs and consecutive branch circuit number-ing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Panelboards: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA PB 1.1.
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
2. Mount top of trim 7.5 ft (2.3 m) above finished floor unless otherwise indicated.
3. Mount panelboard cabinet plumb and rigid without distortion of box.
4. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
5. Install overcurrent protective devices and controllers not already factory installed.

   a. Set field-adjustable, circuit-breaker trip ranges.

6. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
7. Install filler plates in unused spaces.
8. Stub four 1 inch (25 mm) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in future. Stub four 1 inch (25 mm) empty conduits into raised floor space or below slab not on grade.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

B. Panelboard Nameplates: Label each panelboard with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each branch circuit device in power panelboards with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

E. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles must be located on interior of panelboard door.

F. Breaker Labels: Faceplate must list current rating, UL and IEC certification standards, and AIC rating.

G. Circuit Directory:

1. Provide computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

2. Create directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Field tests and inspections must be witnessed by Architect

C. Tests and Inspections:

1. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Nonconforming Work:

1. Panelboards will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Collect, assemble, and submit test and inspection reports, including certified report that identifies panelboards included and that describes scanning results, with comparisons of two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General-grade duplex straight-blade receptacles.
2. Receptacles with ground-fault protective devices.
3. Special-purpose power outlet assemblies.
4. Illuminated duplex receptacles

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 260923 "Lighting Control Devices" for occupancy sensors, timers, control-voltage switches, and control-voltage dimmers.
4. Section 260936 "Modular Dimming Controls" for multiscene and multipreset dimming controls.
5. Section 260943.16 "Addressable Luminaire Lighting Controls" for network lighting control solid-state devices.
6. Section 260943.23 "Relay-Based Lighting Controls" for network lighting control relay devices.
7. Section 262726.11 "General-Use Switches, Dimmer Switches, and Fan-Speed Controller Switches" for additional wiring device products.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product

B. Shop Drawings: List of legends and description of material and process used for pre-marking wall plates. Samples: One of each type of device and wall plate specified in each color specified.

C. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. One for each type of device and wall plate specified, in each color specified.

1.4 CLOSEOUT SUBMITTALS

A. Sustainable Design Closeout Documentation:

1. Refer to Specification SECTION 018113.14 - SUSTAINABLE DESIGN REQUIREMENTS - LEED v4 BD+C for requirements.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Items: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Floor Service-Outlet Assemblies: One for every 10, but no fewer than one.
2. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.

1.6 DESCRIPTION

A. Provide wiring devices as indicated, including cover plates. Wiring devices shall be NEMA type approved for the environmental conditions prevailing.

B. Equipment Termination: Prior to rough-in, verify termination requirements, including, but not limited to, plug-receptacle configuration.

C. All receptacles on emergency power shall be red, all other receptacles shall be white.

PART 2 - PRODUCTS

2.1 SWITCHES

A. 20 amp, 120/277 volt, Construction/Heavy-Duty Specification Grade, back wired and side wired.

2.2 RECEPTACLES

A. 125 volt, Construction/Heavy-Duty Specification, 2 pole, 3 wire grounding, back-wired and side- wired.

2.3 PLATES

A. Plates for flush devices in interior partitions shall be Specification Grade stainless steel Type 302/304.

B. Plates for flush devices in concrete block walls shall be Specification Grade stainless steel Type 302/304 “Jumbo” plates.

C. Plates for devices in surface fittings shall be cadmium-plated steel surface co-vers. Covers shall fit without overlap and have round corners.

D. Plates for heavy-duty outlets and for specialty switches and outlets required for auxiliary systems shall be stainless steel.

E. All metal plates shall be grounded.

F. All cover plates for devices connected to the generator shall be red in color.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receptacles:

1. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

3.2 INSTALLATION OF SWITCHES

A. Comply with manufacturer's instructions.

B. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
3. Consult Architect for resolution of conflicting requirements.

C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."

a. Mark cover or cover plate using hot, stamped, or engraved machine printing with **black** filled lettering, and provide durable wire markers or tags inside device box or outlet box.
b. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

D. Interfaces with Other Work:

1. Coordinate installation of new products for existing conditions.

3.3 INSTALLATION OF STRAIGHT-BLADE RECEPTACLES

A. Comply with manufacturer's instructions.

B. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
4. Consult Architect for resolution of conflicting requirements.

C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
   a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.

D. Interfaces with Other Work:

3.4 INSTALLATION OF LOCKING RECEPTACLES

A. Comply with manufacturer's instructions.

B. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
4. Consult Architect for resolution of conflicting requirements.

C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
   a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.

b. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

D. Interfaces with Other Work:

1. Coordinate installation of new products with existing conditions.

3.5 FIELD QUALITY CONTROL OF SWITCHES

A. Field tests and inspections must be witnessed by Architect

B. Tests and Inspections:

1. Perform tests and inspections in accordance with manufacturers' instructions.
2. See Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

C. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Assemble and submit test and inspection reports.

3.6 FIELD QUALITY CONTROL OF STRAIGHT-BLADE RECEPTACLES

A. Field tests and inspections must be witnessed by Architect

B. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.
6. Healthcare Facilities: Test straight-blade receptacles in patient care spaces with receptacle pin tension test instrument in accordance with NFPA 99. Retention force of ground pin must be not less than 115 g (4 oz).
7. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.

C. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Assemble and submit test and inspection reports.

3.7 FIELD QUALITY CONTROL OF LOCKING RECEPTACLES

A. Acceptance Testing Preparation:

B. Field tests and inspections must be witnessed by Architect

C. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.
6. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.

D. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Assemble and submit test and inspection reports.

3.8 ADJUSTING

A. Occupancy Adjustments for Controlled Receptacles: When requested within **12** months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to **two** visits to Project during other-than-normal occupancy hours for this purpose.

B. Cord Reels and Fittings: Adjust spring mechanisms and moving parts of cord reels and fittings to function smoothly, and lubricate as recommended in writing by manufacturer.

3.9 PROTECTION

A. Devices:

1. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
2. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:

a. Control circuits.
b. Switchboards.
c. Enclosed controllers.
d. Enclosed switches.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bussmann; Eaton, Electrical Sector.
2. Littelfuse, Inc.
3. Mersen USA.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

1. Type RK-1: 250600-V, zero- to 600-A rating, 200 kAIC, time delay.
2. Type RK-5: 250600-V, zero- to 600-A rating, 200 kAIC, time delay.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.2 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Molded-case circuit breakers (MCCBs).
4. Enclosures.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. GFEP: Ground-fault circuit-interrupter for equipment protection.

B. GFLS: Ground-fault circuit-interrupter for life safety.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
2. Enclosure types and details for types other than UL 50E, Type 1.
3. Current and voltage ratings.
4. Short-circuit current ratings (interrupting and withstand, as appropriate).
5. Include evidence of qualified electrical testing laboratory listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
7. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF

B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.6 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed enclosed switches and circuit breakers perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

1.7 DESCRIPTION

A. Provide fused and non-fused disconnect switches as shown on the Drawings, and as required by Code.

B. Fusible switches are indicated on Drawings with a subscript-indicated Buss fuse type/size.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 DISCONNECT SWITCHES

A. NEMA heavy-duty Type HD, steel enclosure, dual-cover interlocks, HP rated plated contacts, indicating handle and provisions for padlocking. Switches shall be NEMA Type approved for the environmental conditions prevailing. Provide Class R rejection fuse clips. Toggle operated disconnect switches equal to Square D Class 2510 shall be acceptable for unfused loads less than 16 amps.

2.3 SWITCH FUSES

A. Bussmann Type LPN R. 250 volt, 600 amps and below. NEMA Class RK 1 and L, dual element, time delay, current-limiting, 200,000 amp. RMS symmetrical interrupting capacity, sizes as shown on the Drawings.

B. Bussmann Type KRP C “Hi Cap.” 601 amps and above. NEMA Class RK 1 and L, dual element, time delay, current-limiting, 200,000 amp. RMS symmetrical interrupting capacity, sizes as shown on the Drawings.

2.4 MOLDED-CASE CIRCUIT BREAKERS

A. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

B. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

C. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.

2. Long- and short-time pickup levels.

3. Long- and short-time time adjustments.

4. Ground-fault pickup level, time delay, and I2t response.

D. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

E. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (5-mA trip).

F. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

G. Type SWD for switching fluorescent lights.

H. Type HACR for heating, air conditioning, and refrigerant equipment.

I. Features and Accessories:

1. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.

2. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered or remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

4. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

PART 3 - EXECUTION

3.1 SELECTION OF ENCLOSURES

A. Indoor, Dry and Clean Locations: UL 50E, Type 1

B. Outdoor Locations: UL 50E, Type 3R

C. Other Wet or Damp, Indoor Locations: UL 50E, Type 4

D. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E, Type 12.

3.2 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
2. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
3. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
4. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
5. Install fuses in fusible devices.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by Architect Coordinate "Tests and Inspections" Paragraph below with "Qualifications" and "Field Quality Control" articles in Section 260010 "Supplemental Requirements for Electrical."

B. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify that unit is clean.
d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
e. Verify that fuse sizes and types match the Specifications and Drawings.
f. Verify that each fuse has adequate mechanical support and contact integrity.
g. Inspect bolted electrical connections for high resistance using one of the following methods:

1) Use low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on Drawings.
i. Verify correct phase barrier installation.
j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
b. Measure contact resistance across each switchblade fuseholder. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage

in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.

e. Perform ground fault test in accordance with NETA ATS Section 7.14 "Ground Fault Protection Systems, Low-Voltage."

3. Electrical Tests:

a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.

b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

c. Perform contact/pole resistance test. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.

d. Perform insulation resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values may be no less than 2 MΩ.

e. Determine the following by primary current injection:

1) Long-time pickup and delay. Pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

2) Short-time pickup and delay. Short-time pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

3) Ground-fault pickup and time delay. Ground-fault pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

4) Instantaneous pickup. Instantaneous pickup values must be as specified and within manufacturer's published tolerances.

f. Test functionality of trip unit by means of primary current injection. Pickup values and trip characteristics must be as specified and within manufacturer's published tolerances.

g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of shunt trip and close coils must be as indicated by manufacturer.

h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset trip logs and indicators. Investigate units that do not function as designed.
i. Verify operation of charging mechanism. Investigate units that do not function as designed.

4. Test and adjust controls, remote monitoring, and safeties.

C. Nonconforming Work:

1. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Collect, assemble, and submit test and inspection reports.

1. Test procedures used.
2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."

END OF SECTION 262816

SECTION 263213.16 - GAS-ENGINE-DRIVEN GENERATOR SETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Gas-engine-driven generator sets.
2. Gas engine.
3. Gas fuel system.
4. Control and monitoring.
5. Generator overcurrent and fault protection.
6. Generator, exciter, and voltage regulator.
7. Vibration isolation devices.

B. Related Requirements:

1. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include plans and elevations for engine generator and other components specified.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer

B. Seismic Qualification Data: Certificates, for engine generator, accessories, and components, from manufacturer.

C. Source quality-control reports.

D. Field quality-control reports.

E. Sample warranty.

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 5 years or 3,000 hours from date of Substantial Completion, including parts labor and travel.

1.7 DESCRIPTION

A. Provide natural gas-fired generator with sound shield weather protective enclosure for loads as indicated by the Owner. If natural gas is not available or feasible, the preferred alternative is propane fired.

PART 2 - PRODUCTS

2.1 GENERATOR

A. Natural gas-fired, liquid-cooled, 4 cycle, 1,800 RPM, with isolators between engine-generator set and skids, radiator, antifreeze, lube oil filter, air cleaner, 120 volt 1.5 KW block heater, flexible exhaust and fuel connections and critical silencer, starting batteries, 120 volt battery charger, radio suppression filters, main line circuit breakers, and control panel.

B. Control panel shall have the following:

1. Voltmeter.

2. Ammeter.

3. Frequency meter.

4. Running Time meter.

5. Oil pressure gauge.

6. Water temperature gauge.

7. Trouble indicators for low oil pressure, high water temperature, overspeed, and overcrank.

C. Controller: Provide the following control functions:

1. Field-programmable time delay for engine start. Adjustment range: 0 5 minutes in 1 second increments.

2. Field-programmable time delay engine cool-down. Adjustment range: 0 10 minutes in 1 second increments.

3. Real-time clock and calendar for time-stamping of events.

4. Output with adjustable timer for starting aid. Adjustment range: 0 10 seconds.

5. Output for shedding of loads if the generator reaches 100% of its KW rating or the generator output frequency falls below 59 Hz.

6. Programmable cyclic cranking that allows up to (6) crank cycles and up to 45 seconds of crank time.

7. Capability to reduce controller current battery draw, for applications where no continuous battery charging is present.

D. Monitored Parameters:

1. Generator:

a. All output voltages: Single-phase, 3 phase, line-to-line, and line to neutral.

b. All single phase and 3 phase currents.

c. Output frequency.

d. System power factor.

e. Total instantaneous kilowatt loading.

f. Display of percent generator duty level — actual KW loading divided by the KW rating.

2. Engine:

a. Coolant temperature both in English and metric units.

b. Oil pressure in English and metric units.

c. Battery voltage.

d. RPM.

E. Alarm Parameters:

1. System shutdown:

a. Customer auxiliary input on any of the (4) inputs available.

b. Emergency stop.

c. High coolant temperature.

e. Controller internal fault.

f. Locked rotor.

g. Low coolant level.

h. Low oil pressure.

i. NFPA common alarm.

j. Overcrank.

k. Overspeed with user-adjustable level. Range: 65 Hz to 70 Hz on 60 Hz systems.

l. Output overvoltage with user-adjustable level. Range: 105% to 135%.

m. Underfrequency with user-adjustable level. Range: 80% to 90%.

n. Undervoltage with user-adjustable level. Range: 70% to 95%.

2. System warning:

a. Battery charger failure.

b. Coolant temperature gauge signal loss.

c. Customer auxiliary input on any of the (4) inputs available.

d. Power system supplying load.

e. Ground fault detected — detected by others.

f. High battery voltage with user-adjustable level. Range: 14.5 volts to 16.5 volts for 12 volt systems and 29 volts to 33 volts for 24 volt systems.

g. High coolant temperature.

h. Load shed.

i. Low output voltage.

j. Low battery voltage with user-adjustable level. Range: 10 volts to 12.5 volts for 12 volt systems and 20 volts to 25 volts for 24 volt systems.

k. Low coolant temperature.

l. Low fuel level or pressure.

m. Low oil pressure.

n. NFPA common alarms.

o. Overcurrent.

p. Oil pressure gauge signal loss.

r. Weak battery.

F. Keyboard Programmable Functions:

1. Time delay settings:

a. Generator run time (0 hours to 72 hours).

b. Enable times for auxiliary inputs.

c. Engine start.

d. Engine cooldown.

e. Overvoltage and undervoltage delays.

f. Starting aid.

g. Crank on and crank pause time.

2. Trip point settings:

a. High battery voltage.

b. Low battery voltage.

c. Overspeed.

d. Underfrequency.

e. Overvoltage.

f. Undervoltage.

G. Alternator shall be 4 pole revolving field, brushless, with radio interference suppression filters, ±5% voltage regulation, and heavy-duty, pre lubricated bearing at engine drive connection.

H. Enclosure: Generator shall be enclosed in a sound shield, weather protective, heavy-gauge, steel housing with removable side panels with lockable latches. Unit shall have fixed louvers sized for proper cooling of engine and generator at 110 deg. F. ambient. Housing shall have (2) rust-inhibiting primer coats, and (2) top finish coats of Manufacturer's standard finish. Critical silencer shall be mounted within the enclosure.

I. Provide a comprehensive full 5 year or 3,000 hour warranty, including parts, labor, and travel.

J. If propane is used, it shall be meet the following requirements: L.P Gas fuel supply pressure, measured at the generator set fuel inlet downstream of any fuel system equipment accessories shall be within the operating range of 1.74-2.74 kPa (7.0-11.0 in. H^2O).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than two working days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

B. Comply with NECA 1 and NECA 404.

C. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.

D. Equipment Mounting:

1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

E. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

F. Exhaust System: Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.

1. Install flexible connectors and steel piping materials according to requirements in Section 232116 "Hydronic Piping Specialties."
2. Insulate muffler/silencer and exhaust system components according to requirements in Section 230719 "HVAC Piping Insulation."
3. Install isolating thimbles where exhaust piping penetrates combustible surfaces with a minimum of 9-inch (225-mm) clearance from combustibles.

G. Drain Piping: Install condensate drain piping to muffler drain outlet with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe, the full size of the drain connection, with welded joints.

H. Gaseous Fuel Piping:

1. Natural gas piping, valves, and specialties for gas distribution are specified in Section 231123 "Facility Natural Gas Piping."

2. LP gas piping, valves, and specialties for gas piping are specified in Section 231126 "Facility Liquefied-Petroleum Gas Piping."

I. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect cooling-system water piping to engine generator and heat exchanger with flexible connectors.

D. Connect engine exhaust pipe to engine with flexible connector.

E. Gaseous Fuel Connections:

1. Connect fuel piping to engines with a gate valve and union and flexible connector.
2. Install manual shutoff valve in a remote location to isolate gaseous fuel supply to the generator.
3. Vent gas pressure regulators outside building a minimum of 60 inches (1500 mm) from building openings.

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

H. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.3 IDENTIFICATION

A. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."

B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Tests and Inspections:

1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in the first two subparagraphs below as specified in the NETA ATS. Certify compliance with test parameters.

   a. Visual and Mechanical Inspection

      1) Compare equipment nameplate data with drawings and specifications.
      2) Inspect physical and mechanical condition.
      3) Inspect anchorage, alignment, and grounding.
      4) Verify the unit is clean.

   b. Electrical and Mechanical Tests

      1) Perform insulation-resistance tests in accordance with IEEE 43.

         a) Machines larger than 200 hp (150 kW). Test duration shall be 10 minutes. Calculate polarization index.
         b) Machines 200 hp (150 kW) or less. Test duration shall be one minute. Calculate the dielectric-absorption ratio.

      2) Test protective relay devices.
      3) Verify phase rotation, phasing, and synchronized operation as required by the application.
      4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
      5) Perform vibration test for each main bearing cap.
      6) Verify correct functioning of the governor and regulator.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

   a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
   b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
   c. Verify acceptance of charge for each element of the battery after discharge.
   d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Exhaust Emissions Test: Comply with applicable government test criteria.
7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
8. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 percent and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
9. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations 25 feet (8 m) from edge of the generator enclosure on the property line and compare measured levels with required values.

F. Coordinate tests with tests for transfer switches and run them concurrently.

G. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.

H. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

I. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

J. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

K. Remove and replace malfunctioning units and reinspect as specified above.

L. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

M. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION 263213.16

SECTION 263600 - AUTOMATIC TRANSFER SWITCHES, BYPASS ISOLATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Bypass/isolation switches

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

1. Technical data on all major components of all transfer switches and other products described in this section. Data is required for the transfer switch mechanism, control system, cabinet, and protective devices specifically listed for use with each transfer switch. Include steady state and fault current ratings, weights, operating characteristics, and furnished specialties and accessories.

2. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Dimensioned outline drawings of assembly, including elevations, sections, and details including minimal clearances, conductor entry provisions, gutter space, installed features and devices and material lists for each switch specified.

2. Internal electrical wiring and control drawings.

3. Interconnection wiring diagrams, showing recommended conduit runs and point-to-point terminal connections to generator set.

4. Installation and mounting instructions, including information for proper installation of equipment to meet seismic requirements.

C. Manufacturer and Supplier Qualification Data

1. The transfer switch manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

2. The manufacturer of this equipment shall have produced similar equipment for a minimum period of 10 years. When requested, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Features and operating sequences, both automatic and manual.

2. List of all factory settings of relays, timers and protective devices; provide setting and calibration instructions where applicable.

E. Warranty documents demonstrating compliance with the project's contract requirements.

1.4 QUALITY ASSURANCE

A. Only approved bidders shall supply equipment provided under this contract.

B. Manufacturer Qualifications: The equipment supplier shall maintain a service center capable of providing training, parts, maintenance and emergency repairs to equipment, including transfer switch generator sets and remote monitoring equipment (if applicable) at the site within a response period of less than (eight hours or appropriate time period designated for Project) from time of notification.

1. The transfer switch shall be serviced by technicians employed by, and specially trained and certified by, the generator set supplier and the supplier shall have a service organization that is factory-certified in both generator set and transfer switch service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

2. The manufacturer shall maintain model and serial number records of each transfer switch provided for at least 20 years.

C. Source Limitations: All transfer switches are to be obtained through one source from a single manufacturer. The generator set manufacturer shall warrant transfer switches to provide a single source of responsibility for products provided.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked as suitable for use in emergency, legally required or optional standby use as appropriate for the connected load.

E. The automatic transfer switch installation and application shall conform to the requirements of the following codes and standards:

1. Transfer switches and enclosures shall be UL 1008 listed and labeled as suitable for use in emergency, legally required, and optional standby applications.

2. NFPA 70, National Electrical Code. Equipment shall be suitable for use in systems in compliance with Articles 700, 701 and 702.

3. Comply with NEMA ICS 10-1993 AC Automatic Transfer Switches
4. IEEE 446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
5. EN55011, Class B Radiated Emissions and Class B Conducted Emissions
6. IEC 1000-4-5 (EN 61000-4-5); AC Surge Immunity
7. IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity
8. IEC 1000-4-2 (EN 61000-4-2) Electrostatic Discharge Immunity
9. IEC 1000-4-3 (EN 61000-4-3) Radiated Field Immunity
10. IEC 1000-4-6 Conducted Field Immunity
11. IEC 1000-4-11 Voltage Dip Immunity
12. IEEE 62.41, AC Voltage Surge Immunity
13. IEEE 62.45, AC Voltage Surge Testing

F. Comply with NFPA 110 – Emergency and Standby Power Systems. The transfer switch shall meet all requirements for Level 1 systems, regardless of the actual circuit level.

G. The manufacturer shall warrant the material and workmanship of the transfer switch equipment for a minimum of five (5) year from the warranty start date. The warranty start date is the date of registered commissioning and start up or eighteen (18) months from date of shipment, whichever is sooner.

H. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, and repair parts costs.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:

1. Notify (Architect/Construction Manager/Owner) no fewer than (insert appropriate number) days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without (Architect/Construction Manager/Owner′s) written permission.
3. Do not energize any new service or distribution equipment without notification and permission of the (Architect/Construction Manager/Owner).

1.6 COORDINATION

A. Size and location of concrete bases and anchor bolt inserts shall be coordinated. Concrete, reinforcement and formwork must meet the requirements specified in Division 03. See section "INSTALLATION" for additional information on installation

B. For bypass switches mounted on a concrete base, the base must be designed to accommodate the requirements of the drawout mechanism (extension rails and/or wheeled carriage) of the bypass switch.

1.7 DESCRIPTION

A. Provide an enclosed automatic emergency transfer switch that is compatible with the generator.

PART 2 - PRODUCTS

2.1 AUTOMATIC TRANSFER SWITCH

A. 3 pole transfer switch with fully rated solid neutral plates. UL listed, mechanically held, electrically operated, silver alloy wiping action contacts, silver alloy-plated main contacts, operating handle, sensing relays. Microprocessor-based control module panel, including programming keypad, display, program selector switch, and LED status indication. Accessories for the following features:

1. Voltage sensing on both normal and emergency sources, pickup 90%, drop out 85%, adjustable.

2. Momentary outage timer: 1 seconds to 6 seconds, set at 3 seconds.

3. Return-to-normal timer: 0 minutes to 30 minutes, set at 8 minutes.

4. Cool-down timer: 0 minutes to 30 minutes, set at 5 minutes.

5. Time delay on transfer to emergency: 0 seconds to 30 seconds, set at 0 seconds.

6. Auxiliary contact normal and emergency.

7. Test switch and pilot lights.

8. Engine generator exercise timer with reserve power feature.

B. Transfer switches shall return to NORMAL position only by manual reset button. Provide relays and modify controls as required.

C. Withstand and closing RMS symmetrical short circuit current rating shall be 200,000 amps with current-limiting fuses.

D. Provide comprehensive full 5-year warranty including parts, labor, and travel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Floor-Mounting Switch: Anchor to floor by bolting.

1. Floor-mounted transfer switches (except drawout switches supported by wheeled carriages, which must be rolled out at floor level) shall be mounted on concrete bases complying with the following requirements:

a. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

C. Identify components according to Division 26 Section "Identification for Electrical Systems."

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.

C. Transfer switch shall be provided with AL/CU mechanical lugs sized to accept the full output rating of the switch. Lugs shall be suitable for the number and size of conductors shown on the drawings.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 SOURCE QUALITY CONTROL

A. Prior to shipping, factory shall test and inspect components, assembled switches, and associated equipment to ensure proper operation.

B. Factory shall check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements.

C. Factory shall perform dielectric strength test complying with NEMA ICS 1.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: The supplier of the transfer switch(es) and associated equipment shall inspect, test, and adjust components, assemblies, and equipment installations, including connections, and report results in writing.

B. Manufacturer′s representative shall perform tests and inspections and prepare test reports.

C. After installing equipment and after electrical circuitry has been energized, installer shall test for compliance with requirements.

1. Perform recommended installation tests as recommended in manufacturer′s installation and service manuals.

2. After energizing circuits, demonstrate interlocking sequence and operational function for each switch.

a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.

b. Verify time-delay settings.

c. Verify that the transfer switch is accurately metering AC voltage and current.

d. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.

e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

3.5 DEMONSTRATION

1. After generator set installation, the generator and transfer switch supplier shall conduct a complete operation, basic maintenance, and emergency service training session covering generator set and transfer switch equipment. The training session shall include instruction on operation of the transfer equipment, normal testing and exercise, and adjustments to the control system.

END OF SECTION 263600

SECTION 264313 - SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type 1 surge protective devices (SPDs).
2. Type 2 surge protective devices (SPDs).

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 262413 "Switchboards" for integral SPDs installed by switchboard manufacturer.
4. Section 262416 "Panelboards" for integral SPDs installed by panelboard manufacturer.

1.2 DEFINITIONS

A. I_n: Nominal discharge current.

B. Voltage Protection Rating (VPR): A rating selected from UL 1449 list of preferred values assigned to each mode of protection.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include electrical characteristics, specialties, and accessories for SPDs.
b. Certification of compliance with UL 1449 by qualified electrical testing laboratory recognized by authorities having jurisdiction including the following information:

1) Tested values for VPRs.
2) I_n ratings.
3) MCOV, type designations.
4) OCPD requirements.
5) Manufacturer's model number.
6) System voltage.
7) Modes of protection.

B. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.5 WARRANTY

A. Special Manufacturer Extended Warranty: Manufacturer warrants that SPDs perform in accordance with specified requirements and agrees to provide repair or replacement of SPDs that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: Five year(s) from date of Substantial Completion, for labor, materials, and equipment.

1.6 DESCRIPTION

A. Provide 208/120-volt, 3 phase surge protection device on Switchboard “MDP.”

B. Provide 3 phase surge protection device on Panelboards, as shown on Drawings.

PART 2 - PRODUCTS

2.1 TRANSIENT VOLTAGE SURGE SUPPRESSORS — MAIN SWITCHBOARD

A. Current Technology Model TG150 120/208 3GY. Provide 208/120 volt, 3 phase surge protection device on Switchboard “MDP” with neon status indicator lights, peak surge current of 150,000 amps per mode, UL 1449 Standard, Second Edition, and 5 year warranty. Wire to 100/3 switch fused at 70 amps with #2 AWG wiring.

2.2 TRANSIENT VOLTAGE SURGE SUPPRESSORS — BRANCH PANELBOARD

A. Current Technology Model TG60 120/208 3GY. Provide 3 phase surge protection device with neon status indicator lights, peak surge current of 60,000 amps per mode, UL 1449 Standard, Second Edition, and 5 year warranty on all panelboards. Wire to 70 amp, 3 pole circuit breaker with #2 AWG wiring.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's instructions.

3.2 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by Architect Coordinate "Tests and Inspections" Paragraph below with "Qualifications" and "Field Quality Control" articles in Section 260010 "Supplemental Requirements for Electrical."

B. Tests and Inspections:

1. Compare equipment nameplate data for compliance with Drawings and the Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's installation requirements.

C. Nonconforming Work:

1. SPDs that do not pass tests and inspections will be considered defective.
2. Remove and replace defective units and retest.

D. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Complete startup checks in accordance with manufacturer's instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

END OF SECTION 264313

SECTION 265119 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following types of LED luminaires:

1. Downlight.
2. Recessed, linear.
3. Strip light.
4. Surface mount, linear.
5. Surface mount, nonlinear.
6. Suspended, linear.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
2. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Sustainable Design Submittals:

1. Refer to Specification SECTION 018113.14 - SUSTAINABLE DESIGN REQUIREMENTS - LEED v4 BD+C for requirements.

D. Samples: For each luminaire and for each color and texture with standard factory-applied finish.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale and coordinated with each other, using input from installers of the items involved.

B. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.

C. Product Certificates: For each type of luminaire.

D. Product test reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.6 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: 5 year(s) from date of Substantial Completion.

1.7 DESCRIPTION

A. Provide LED lighting fixtures complete with drivers, frames, canopies, hangers, straps, and trim, as required for a complete installation.

B. Coordinate fixture moutning type with ceiling type listed on the Architectural Room Finish Schedule.

PART 2 - PRODUCTS

2.1 REQUIREMENTS

A. CRI - minimum of 70. COLOR CORRECTED TEMPERATURE of 4100 K.

B. Rated lamp life of 50,000 hours.

C. If lamps dimmable from 100 percent to 0 percent of maximum light output.

D. Fixtures shall have internal drivers unless specifically permitted/required by the fixture selection or installation.

E. Fixtures shall have internal drivers unless specifically permitted/required by the fixture selection or installation.

F. Copies of all light fixture cut sheets/product data will be submitted for review by the owner as part of the Construction Document submission.

2.2 RECOMMENDED LIGHTING LEVELS

A. Office Areas – 35-50-foot candles average

B. Parking Lots and Sidewalks – 1-foot candle average

C. Maintenance/Welding Bays – 50-foot candles average

D. Truck Storage – 25-foot candles average.

1. This level can be increased to 50-foot candles average if vehicles are being examined within the facility without additional task lighting

E. Enclosed storage buildings – 15-foot candles average

F. Fuel Islands – 15-foot candles average. At a minimum, provide a single pole and fixture within the island for each dispenser.

G. Brine Filling Station – 15-foot candles average

H. Mechanical and Electrical Rooms – 20-foot candles average

I. Data and Telecommunications Rooms – 25-foot candles average

J. Parts Room – 30-foot candles average

K. Compressor Room – 20-foot candles average

L. Oil Storage Room – 20-foot candles average

M. Wash Bay – 30-foot candles average

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

E. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.2 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Comply with requirements for startup specified in Section 260943.16 "Addressable-Luminaire Lighting Controls."

END OF SECTION 265119

SECTION 265213 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Emergency lighting.
2. Exit signs.
3. Materials.
4. Luminaire support components.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of emergency lighting unit, exit sign, and emergency lighting support.

a. Include data on features, accessories, and finishes.
b. Include physical description of unit and dimensions.
c. Battery and charger for light units.
d. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
e. Include photometric data and adjustment factors based on laboratory tests by, or under supervision of, qualified luminaire photometric testing laboratory, for each luminaire type.

B. Shop Drawings:

1. For nonstandard or custom luminaires.

a. Include plans, elevations, sections, and mounting and attachment details.
b. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
c. Include diagrams for power, signal, and control wiring.

C. Samples: For each product and for each color and texture specified.

D. Samples for Initial Selection: For each type of luminaire with factory-applied finishes.

E. Samples for Verification: For each type of luminaire.

1. Include Samples of luminaires and accessories to verify finish selection.

F. Product Schedule:

1. For emergency lighting units. Use same designations indicated on Drawings.
2. For exit signs. Use same designations indicated on Drawings

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of luminaire.

B. Sample Warranty: For manufacturer's warranty.

1.4 WARRANTY

A. Special Installer Extended Warranty for Emergency and Exit Lighting: Installer warrants that fabricated and installed emergency luminaires and exit signs, including batteries, perform in accordance with specified requirements and agrees to repair or replace components and assemblies that fail to perform as specified within extended warranty period.

1. Extended Warranty Period: Two year(s) from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 and UL 924, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Comply with NFPA 101.

C. Comply with NEMA LE 4 for recessed luminaires.

D. Comply with UL 1598 for fluorescent luminaires.

E. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.

1. Emergency Connection: Operate fixture continuously at an output of 100% lumens each upon loss of normal power.
2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay

disconnects lamps from battery, and battery is automatically recharged and floated on charger.

3. Nightlight Connection: Operate lamp continuously at 100% percent of rated light output.
4. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.

    a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

5. Battery: Sealed, maintenance-free, nickel-cadmium type.
6. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.2 EMERGENCY LIGHTING

A. General Characteristics: Self-contained units.

B. Emergency Luminaire refer to interior lighting plans:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Amerlux.
    b. Architectural Lighting Works.
    c. Cooper Lighting Solutions; Signify North America Corp.
    d. Dual-Lite; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    e. GE Current, a Daintree company; American Industrial Partners (AIP).
    f. Juno Lighting Group by Schneider Electric.
    g. Lithonia Lighting; Acuity Brands Lighting, Inc.
    h. Philips; Signify North America; Signify Holding.

2. Options:

    a. Operating at nominal voltage of 277 Vac Coordinate requirements below with "Emergency Power Units" Article.
    b. External emergency power unit.
    c. Rated for installation in damp locations, and for sealed and gasketed luminaires in wet locations.
    d. UL 94 V-0 flame rating.

2.3 EXIT SIGNS

A. General Characteristics: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Sign See Drawing Schedule:

1. Options:

a. Operating at nominal voltage of **120 V(ac)**.
b. Lamps for AC Operation:
1) LEDs; 50,000 hours minimum rated lamp life.

2.4 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components must be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Refer to specification sheets Diffuse glass, Clear glass, Prismatic acrylic, Clear, UV-stabilized acrylic.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
4. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

D. Housings:

1. Refer to fixture specifications.

2.5 METAL FINISHES

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.

2.6 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

B. Install lamps in each luminaire.

C. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position when testing emergency power unit.
3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
4. Luminaire-mounting devices must be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.

D. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

E. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inch (1200 mm), brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod or wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

F. Ceiling Grid Mounted Luminaires:

1. Secure to outlet box, if provided.
2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.

3.2 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by tenant, authorities having jurisdiction.

B. Tests and Inspections:

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

C. Nonconforming Work:

1. Luminaire will be considered defective if it does not pass operation tests and inspections.
2. Remove and replace defective units and retest.

D. Prepare test and inspection reports.

E. Manufacturer Services:

1. Engage factory-authorized service representative to support and supervise field tests and inspections.

3.4 ADJUSTING

A. Adjustments: Within 1 months of date of Substantial Completion, provide on-site visit to do the following:

1. Inspect luminaires. Replace drivers, batteries, exit signs and luminaires that are defective.

a. Parts and supplies must be manufacturer's authorized replacement parts and supplies.

2. Conduct short-duration tests on all emergency lighting.

3.5 PROTECTION

A. Remove and replace luminaires and exit signs that are damaged or caused to be unfit for use by construction activities.

END OF SECTION 265213

SECTION 265619 - LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
2. Luminaire supports.
3. Luminaire-mounted photoelectric relays.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Delegated Design Submittals: For luminaire supports.

1. Include design calculations for luminaire supports and seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale and coordinated.

C. Product Certificates: For each type of the following:

1. Luminaire.
2. Photoelectric relay.

D. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

1.6 FIELD CONDITIONS

A. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.7 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 5 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 REQUIREMENTS

A. CRI - minimum of 70. COLOR CORRECTED TEMPERATURE of 4100 K.

B. Rated lamp life of 50,000 hours.

C. If lamps dimmable from 100 percent to 0 percent of maximum light output.

D. Fixtures shall have internal drivers unless specifically permitted/required by the fixture selection or installation.

E. Copies of all light fixture cut sheets/product data will be submitted for review by the owner as part of the Construction Document submission.

2.2 RECOMMENDED LIGHTING LEVELS

A. Parking Lots and Sidewalks – 1-foot candle average

B. Fuel Islands – 15-foot candles average. At a minimum, provide a single pole and fixture within the island for each dispenser.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Fasten luminaire to structural support.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

E. Wall-Mounted Luminaire Support:

1. Attached to backing plate provided with fixtures attached to wall structural

F. Wiring Method: Install cables in raceways. Conceal raceways and cables.

G. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at height and aiming angle as indicated on Drawings.

H. Coordinate layout and installation of luminaires with other construction.

I. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533.13 "Conduits for Electrical Systems" for wiring connections and wiring methods.

3.2 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

A. Aim as indicated on Drawings.

3.3 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 260533.13 "Conduits for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections.

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Photoelectric Control Operation: Verify operation of photoelectric controls.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):

   a. IES LM-64.
   b. IES LM-72.

2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

D. Luminaire will be considered defective if it does not pass tests and inspections.

E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaires, controls, and control components.

END OF SECTION 265619

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Telecommunications mounting elements.
2. Backboards.
3. Telecommunications equipment racks and cabinets.
4. Grounding.

B. Related Requirements:

1. Section 271300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
2. Section 271500 "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer**,** qualified layout technician, installation supervisor, and field inspector.

B. Seismic Qualification Certificates: For equipment frames from manufacturer.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

1.5 WORK DESCRIPTION

A. Contractor is responsible for the Work described in this Section.

B. Voice and data installer MUST be a BICSI-Certified Installer Cabling Company. This Company shall provide all of the paging, voice, and data cabling on this Project.

C. Telephone Service:

1. For underground telephone service, refer to Section 33 70 00.01.

2. Provide all trenching and backfill.

3. Provide all underground telephone services and conduits as shown on drawings. Provide pullwire in all conduits, including spare conduits.

4. Provide Unistrut supports and 3/4 in. thick painted fire-resistant 4 ft. x 4 ft. sheet of plywood at the telecommunications entrance facility for demarcation box location. The entrance facility should be near, but not closer than 2 ft. from, the entrance of the electrical service.

5. Ensure the installation conforms in all respects to the requirements of the Local Telephone Company, which shall govern these Specifications.

6. Provide (1) quadruplex 120-volt receptacle, connected to the emergency power system. Also provide any backboard and conduit sleeves through the floor.

7. Provide (2) 3 in. conduits from telephone demarcation box to the designated location for the voice/network backboard. Provide 50 pair telephone cable in one conduit with 4 ft. spare cable at each end for Telephone Company terminations.

8. Provide a minimum 25-pair cable between the phone backboard and the main network rack.

9. Provide analog voice circuits (extended from the service provider's point of demarcation as required for all fax machines, fire alarm, security system, etc. as required.

D. Network Communication Room:

1. Provide conduit and conduit sleeves as required. At a minimum, each room adjacent to a corridor shall be provided (2) 2” bushed sleeves.

2. Provide UL-listed fire stop where conduits and conduit sleeves penetrate fire-rated walls or floors.

3. Installation shall conform in all respects to IEES requirements.

4. (2) quadruplex – 110-volt 20amp receptacles connected to emergency power system dedicated for (1) or (2) S2 Panels wall mounted, (1) or (2) S2 Power Panels wall mounted, (1) DMP Panel wall mounted and (1) Milestone NVR (rack mounted).

5. (3) quadruplex – 110-volt 20amp receptacles connected to emergency power system dedicated for rack mounted network routers, switches and other devices.

6. 3/4x4x8 AC grade plywood sheets mounted vertically on three walls for security and other panels

7. (1) Cable Management Rack System (Siemon RS3-07 with (4) RS3-RWM-2DS horizontal cable managers or equivalent) - Provided and installed by contractor

8. (2) 6 Strand Armored Single-Mode Fiber – Provided and installed by utility provider (Typically AT&T and Time Warner)

9. (6) Phone lines – 25 pair cable – Provide and installed by utility provider (2-local business lines, 2- fire monitoring, 1- fax line and 1- security line)

10. (1) Fiber Rack Mount Enclosure – (Corning Cable Systems CCH-01U or equivalent) – Provided and installed by contractor

11. (2) Rack Mount Cat 6 Patch Panel 48 Port – (Leviton eXtreme Cat 6 Flat 110-Style Patch Panel or equivalent) for network – Provided and installed by contractor

12. (1) Rack Mount Cat 6 Patch Panel 24 Port – (Leviton eXtreme Cat 6 Flat 110-Style Patch Panel or equivalent) for access control and security - Provided and installed by contractor

13. (1) 6 Strand Multi-Mode Fiber – To Secured Cold Storage – (Corning Part Nr. 006K8F-31130-29 FREEDOM® One Tight-Buffered Cable, Riser,6 F, 50 µm multi-mode (OM3) or equivalent) - Provided and installed by contractor

14. LC Connectors on terminated fiber when applicable – Provided and installed by contractor

15. (7) 18g 2 strand speaker cable – (2) to truck storage, (1) to secured cold storage, (1) to mechanics bays, (1) to non- secured storage building and (2) to yard area – Provided and installed by contractor

16. (2) Cat6, 23 AWG, UTP spline-less (Plenum CPM rated as needed), 8C Solid Copper, 550MHz, cable – From Network Communication Room – Provided and installed by Contactor

17. Network Router, Network Switch and UPS – Provided and installed by owner

18. Paging Equipment – Cisco ATA 186 Analog Telephone Adapter, Viking SLP-1 Paging Controller, Valcom Microphone Adapter (V-9939B), Bogen Reentrant Horn Loudspeakers (Model SPT15A) and Bogan Ceiling Speakers (S86T725PG8WBR) & Grilles (S86T725PG8WVK) – Provided and installed by Contractor

E. Secured Cold and Other Secured Buildings:

1. Provide a network cabinet for outbuildings (24H”x24d”x”24w”) on the campus as required for networking and security equipment.

2. Provide wall outlets, conduits, and cables. (Network T-Racks, Network Cabinet for outbuildings (24H”x24d”x”24w”) is needed in outbuildings where Security panels are located to house small network switch for (S2 nodes, cameras, wireless devices)

3. (1) quadruplex – 110-volt 20amp receptacle connected to emergency power system dedicated for S2 Panel, S2 Power Panel & security.

4. (1) quadruplex – 110-volt 20amp receptacle connected to emergency power system dedicated for a network panel and other network devices.

5. (1) 3/4x4x8 AC grade plywood sheet mounted vertically on wall for security and network panels.

6. (1) Wall Mount Enclosure – (Great Lakes Case & Cabinet Co. Model GL24WM (24”x22.25”x24”) or equivalent) – Provided and installed by contactor

7. (1) Fiber Rack Mount Enclosure – (Corning Cable Systems CCH-01U or equivalent) – Provided and installed by contactor

8. (1) Rack Mount Cat 6 Patch Panel 24 Port – (Leviton eXtreme Cat 6 Flat 110-Style Patch Panel or equivalent) – Provided and installed by contractor

9. (1) 6 Strand Multi-Mode Fiber – From Network Communication Room - (Corning Part Nr. 006K8F-31130-29 FREEDOM® One Tight-Buffered Cable, Riser,6 F, 50 µm multi-mode (OM3) or equivalent) – Provided and installed by contactor

10. LC Connectors on terminated fiber when applicable – Provided and installed by contractor

11. (1) 18g 2 strand speaker cable – From Network Communication Room – Provided and installed by contractor

12. (2) Cat6, 23 AWG, UTP spline-less (Plenum CPM rated as needed), 8C Solid Copper, 550MHz, cable – From Network Communication Room – Provided and installed by contactor

F. Non-Secured Storage Buildings (Excluded Salt Storage):

1. Provide a network cabinet for outbuildings (24H”x24d”x”24w”) on the campus as required for networking and security equipment.

2. Provide wall outlets, conduits, and cables. (Network T-Racks, Network Cabinet for outbuildings (24H”x24d”x”24w”) is needed in outbuildings where Security panels are located to house small network switch for (S2 nodes, cameras, wireless devices)

3. (1) quadruplex – 110-volt 20amp receptacle connected to emergency power system dedicated for S2 Panel, S2 Power Panel & security.

4. (1) quadruplex – 110-volt 20amp receptacle connected to emergency power system dedicated for a network panel and other network devices.

5. (1) 3/4x4x8 AC grade plywood sheet mounted vertically on wall for security and network panels.

6. (1) 18g 2 strand speaker cable – From Network Communication Room.

G. Conduit Requirements for Network and Security:

1. Network Provider (from the Pole) to the Network Communications Room

   (3) – 4” conduits (with pull string)

2. Network Communications Room to each Gate Controller

   (1) – 2-1/2” conduit (with pull string) from Network Communications Room to each gate controller

   (1) – 1-1/2” conduit (with pull string) from each gate controller to the card reader/intercom pedestal

3. Network Communications Room to Truck Storage area or Building

   (1) – 2-1/2” conduit (with pull string) for network 6 strand multi-mode fiber, Cat-6 cable & paging wire

   (1) – 2-1/2” conduit (with pull string) for security cable, fiber & Cat-6 cable

   (1) – 2-1/2” conduit (with pull string) spare

4. Network Communications Room to Secured Cold Storage and other Secured Buildings

   (1) – 2-1/2” conduit (with pull string) for network 6 strand multi-mode fiber, Cat-6 cable & paging wire

   (1) – 2-1/2” conduit (with pull string) for security cable, fiber & Cat-6 cable

   (1) – 2-1/2” conduit (with pull string) spare

5. Network Communications Room to Non-Secured Storage Buildings (Excludes Salt Storage)

   (1) – 2-1/2” conduit (with pull string) for network 6 strand multi-mode fiber, Cat-6 cable

& paging wire

(1) – 2-1/2” conduit (with pull string) for security cable, fiber & Cat-6 cable

(1) – 2-1/2” conduit (with pull string) spare

6. Network Communications Room to Fuel Island

(1) – 1” conduit (with pull string) spare to a light pole mounted on the fuel island

(2) – 2-1/2” conduit (with pull string) spare for future data/security cable and fiber to be terminated in a weatherproof junction box (field verify location with owner)

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Equipment frames shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7**.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 PLYWOOD BACKBOARDS

A. Provide AC grade ¾” x 8’ void free plywood mounted vertically on the wall. Plywood shall be painted on all six sides with gray fire retardant paint. Plywood to be installed on a minimum of (3) three walls within the Communications Room.

2.3 EQUIPMENT FRAMES

A. General Frame Requirements:

1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Module Dimension: Width compatible with EIA 310-D standard, 19-inch (480-mm) panel mounting.
3. Finish: Manufacturer's standard, baked-polyester powder coat.

B. Floor-Mounted Racks: Modular-type, aluminum construction.

1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
2. Baked-polyester powder coat finish.

C. Modular Freestanding Cabinets:

1. Removable and lockable side panels.
2. Hinged and lockable front and rear doors.
3. Adjustable feet for leveling.
4. Screened ventilation openings in the roof and rear door.
5. Cable access provisions in the roof and base.
6. Grounding bus bar.
7. **Roof**-mounted, 550-cfm (260-L/s) fan with filter.
8. Power strip.
9. Baked-polyester powder coat finish.
10. All cabinets keyed alike.

D. Cable Management for Equipment Frames:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.4 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting.
3. Twenty, 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
4. LED indicator lights for power and protection status.
5. LED indicator lights for reverse polarity and open outlet ground.
6. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
7. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
8. Rocker-type on-off switch, illuminated when in on position.

2.5 GROUNDING AND BONDING BUSBARS

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

1. Telecommunications Main Ground Bar (TMGB):

a. Electro-tin plated ¼” thick copper bar.

b. Insulated stand-offs.

c. 15 pairs of 5/8” holes and 3 pairs of 1” holes.

d. 4” high x 12” wide.

2. Design Basis Telecommunications Main Ground Bar (TMGB) – Chatsworth Products 40153-012, Homaco WMBB-20, or Hubbell RKTGB.

3. Telecommunications Ground Bar (TGB):

a. Electro-tin plated ¼” thick copper bar.

b. Insulated stand-offs.

c. 8 pairs of 5/16” holes and 3 pairs of 7/16” holes.

d. 2” high x 12” wide.

4. Equipment Rack Busbar:

a. 3/16” thick x .75” high x 19” wide rack-mount ground busbar for equipment racks and cabinets.

b. Mounts to standard mounting rails.

c. 8 #6-32 tapped holes and 2 pairs of 5/16” holes.

5. Design Basis Equipment Rack Busbar – Siemon, Ortronics Commscope or Panduit

B. BONDING CONDUCTORS

1. All bonding conductors shall be constructed of bare, soft annealed copper per ASTM B-3 and have a high dielectric PVC insulation per UL-3 and UL-1063. Overall jacket shall conform to UL-83 for THHN-THWN type cables.

2. Jacket coloring for the bonding conductor shall be green. If green is not available, the contractor is to identify the cable as being a bonding conductor by providing a 2” wide band of green electrical tape at each end of the bonding conductor and at each accessible path throughout the conduit system.

3. The BC and TEBC shall be #6 AWG, minimum; The TBBC shall be a #3/0 AWG; The TBBIBC shall be #6 AWG, minimum.

C. BONDING CONDUCTOR TERMINATIONS

1. One hole compression lugs: Thomas and Betts, “Long Barrel One Hole Lugs” color code blue (example Catalog Number 54905BE) high conductivity wrought copper, electro-tin plate, or equal by Chatsworth Products, Erico or Burndy.

2. Two hole compression lugs: Thomas and Betts, “Two Hole Lugs Long Barrel Type” color code blue (example Catalog Number 54816BE) high conductivity wrought copper, electro-tin plate, or equal by Chatsworth Products, Erico or Burndy.

2.6 LABELING

B. Comply with TIA/EIA-606 and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.7 TELEPHONE/DATA OUTLETS

A. Provide flush 3 in. x 2 in. x 3 1/2 in. deep wall data and telephone/data outlet box with single gang cover/plaster ring (no cover plates). Extend 1 in. conduit with bushed ends to above accessible lay-in ceiling. Conduit shall be sized for cable conductor count.

2.8 CABLES

A. Refer to Specification 27 15 00 Communications Horizontal Cabling.

B. Provide Cat-6 network cabling as required for desktop PCs, wireless access points, security cameras.

C. Provide paging cabling as required.

D. Provide fiber optic backbone cabling (6 Strand min.) to all campus buildings as well as any fuel pump beyond UTP structured cabling limits.

E. All cabling to be terminated in relay racks or enclosures provided by the installer.

2.9 RELAY RACKS

A. All structured cabling terminating in the TRs shall be installed in relay racks.

B. Relay racks shall be constructed of 6063-T2 aluminum with a durable black powder coat finish. When properly secured to the floor the racks shall have a 500 lbs. (static) weight capacity.

C. Relay racks shall be UL-7N69 listed and have EIA-310-D universal spacing tapped #12-24 front and rear.

D. Design Basis 7' Relay Rack – Hubbell HPW84RR19, Middle Atlantic RLA19-1245B, or Chatsworth 46753-703.

E. Relay racks shall be equipped with 6" wide vertical cable management on both the front and the rear of the relay rack as shown on the detail plans. Covers on both the front and rear shall be hinged with a durable black powder coat finish.

F. Design Basis 6" Vertical Organizer – Hubbell VC76H; Middle Atlantic CK-45 (center) or CK-45e (end) with CK-45C (cover) or Chatsworth Products 57003-703.

2.9 CABLE LADDER

A. Provide cable ladder above the cabinet/rack assemblies and on the backboard as shown on the drawings.

B. Cable ladder shall be powder coated black and constructed of 3/8" x 1-1/2" tubular steel. Cross members shall be welded at 12" intervals.

C. Design Basis 18” Cable Ladder – Hubbell HLS1018B, Chatsworth 10250-718 or Cooper B-Line SB17U18BFB.

D. Design Basis 12” Cable Ladder – Hubbell HLS1012B, Chatsworth 10250-712 or Cooper B-Line SB17U12BFB.

E. Provide as required radius drops, radius bends, splice kits, corner brackets and all additional hardware required for a complete system.

3 EXECUTION

3.7.1.1 ENTRANCE FACILITIES

3.7.1.1.1 Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

3.7.1.2 INSTALLATION

3.7.1.2.1 Comply with NECA 1.

3.7.1.2.2 Comply with BICSI TDMM for layout and installation of communications equipment rooms.

3.7.1.2.3 Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.7.1.2.4 Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

3.7.1.2.4.1 Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.

3.7.1.2.4.2 Record agreements reached in meetings and distribute them to other participants.

3.7.1.2.4.3 Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.

3.7.1.2.4.4 Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

3.7.1.2.5 Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.7.1.3 SLEEVE AND SLEEVE SEAL INSTALLATION FOR PENETRATIONS

3.7.1.3.1 Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.7.1.4 FIRESTOPPING

3.7.1.4.1 Comply with requirements in Section 078413 "Penetration Firestopping."

3.7.1.4.2 Comply with TIA-569-E.

3.7.1.4.3 Comply with BICSI TDMM, "Firestopping Systems" Article.

3.7.1.5 GROUNDING

3.7.1.5.1 Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

3.7.1.5.2 Comply with ANSI/TIA-607-D.

3.7.1.5.3 Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar.

3.7.1.5.4 Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.7.1.5.4.1 Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.7.1.6 IDENTIFICATION

3.7.1.6.1 Identify system components, wiring, and cabling complying with ANSI/TIA-606-C. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

3.7.1.6.2 Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

3.7.1.6.3 Labels shall be preprinted or computer-printed type.

END OF SECTION 271100

SECTION 271300 - COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pathways.
2. UTP cable.
3. Cable connecting hardware, patch panels, and cross-connects.
4. Cabling identification products.

B. Related Sections:

1. Section 280513 "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.2 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

C. The structure cabling system shall be provided with a 25 year manufacturer’s warranty.

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in ANSI/TIA-568-D.1, when tested according to test procedures of this standard.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. Cabling administration drawings and printouts.
3. Wiring diagrams to show typical wiring schematics including the following:

a. Cross-connects.
b. Patch panels.
c. Patch cords.

4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
5. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings**,** Cabling Administration Drawings, and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Telecommunications Pathways and Spaces: Comply with ANSI/TIA-569-E.

D. Grounding: Comply with ANSI/TIA-607-D.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site. Test each pair of UTP cable for open and short circuits.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

B. Cable Trays:
1. Cable Tray Material: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inches (0.012 mm) thick.

a. Basket Cable Trays: 12 inches (150 mm) wide and 4 inches (50 mm) deep. Wire mesh spacing shall not exceed 2 by 4 inches (50 by 100 mm).
b. Ladder Cable Trays: Nominally 18 inches (455 mm) wide, and a rung spacing of 12 inches (305 mm).

C. Conduit and Boxes: Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels.

2.3 UTP CABLE

A. Description: 100-ohm, 100-pair UTP, formed into 25-pair binder groups covered with a gray thermoplastic jacket and overall metallic shield.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with ANSI/TIA-568-D for performance specifications.
3. Comply with ANSI/TIA-568-D, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

a. Communications, General Purpose: Type CM or CMG.
b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
c. Communications, Riser Rated: Type CMR, complying with UL 1666.

2.4 UTP CABLE HARDWARE

A. General Requirements for Cable Connecting Hardware: Comply with ANSI/TIA-568-D, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

B. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

C. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

D. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

E. Patch Cords: Factory-made, 4-pair cables in 48-inch (1200-mm) lengths; terminated with 8-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

2.5 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with ANSI/TIA-607-D.

2.6 IDENTIFICATION PRODUCTS

A. Comply with ANSI/TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.7 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to ANSI/TIA-568-D.

C. Factory test UTP cables according to ANSI/TIA-568-D.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceway and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and ANSI/TIA-569-E.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

C. Comply with ANSI/TIA-569-E for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows.

F. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches (76 mm) above finished floor.

5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with ANSI/TIA-568-D.
2. Install 110-style IDC termination hardware unless otherwise indicated.
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
9. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.

C. UTP Cable Installation:

1. Comply with ANSI/TIA-568-D.
2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with ANSI/TIA-569-E recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.5 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with ANSI/TIA-569-E.

3.6 GROUNDING

A. Comply with ANSI/TIA-607-D.

B. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding

bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

C. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with ANSI/TIA-606-C. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Administration Class: 2.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with ANSI/TIA-606-C for Class 2 level of administration.

D. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

F. Cable and Wire Identification:

1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

   a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
   b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware.

Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in ANSI/TIA 606-C, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect UTP jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with ANSI/TIA-568-D.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

a. Test instruments shall meet or exceed applicable requirements in ANSI/TIA-568-D. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

B. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report or transferred from the instrument to the computer, saved as text files, and printed and submitted.

C. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

D. Prepare test and inspection reports.

END OF SECTION 271300

SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. UTP cabling.
2. Cable connecting hardware, patch panels, and cross-connects.
3. Telecommunications outlet/connectors.
4. Cabling system identification products.

B. Related Requirements:
1. Section 280513 "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

C. All work shall be performed by competent workmen and executed in a neat and workmanlike manner providing a thorough and complete installation. Work shall be properly protected during construction, including the shielding of soft or fragile materials.

D. At completion, the installation shall be thoroughly cleaned and all tools, equipment, obstructions, or debris present as a result of this portion of work shall be removed from the premises.

E. The Contractor must demonstrate to the Owner and Engineer that the systems are complete and complies with all operational requirements set forth in the plans and specifications.

F. The Contractor shall provide all miscellaneous items and accessories required to make the system operational whether or not such items are specifically mentioned in the plans and specifications.

G. It is the Contractor's responsibility to review the architectural, structural, mechanical, and electrical drawings, as well as the specifications, for any details that may impact the installation or provisioning of the system. Any discrepancies discovered shall be brought to the attention of the Engineer.

H. STRUCTURED CABLING
1. The Structured Cabling Basis of Design is Siemon's Solution 6. Equal solutions by Ortronics, Commscope, or Panduit maybe accepted provided the performance requirements and standards of the equal solutions are equal to or better than Siemon's Solution 6. This Contractor shall be a certified installer for the structured cabling solution utilized, and shall provide a minimum twenty (20) year extended Product and Applications Assurance warranty on parts and.

2. This Contractor shall be a certified installer for the manufacturer utilized. Siemons

Solution 6, Ortronics NetClear GT2, Commscope UniPrise 6 or Panduit TX6000 Systems.

3. Provide Cat-6 cabling as required to serve each buildings unique cabling needs. Where applicable, Cat-6 cabling location shall be installed adjacent to and at the same elevation as the associated power outlet.

4. At a minimum, provide (2) Category 6 cables from each workstation back to the IT Room serving the area. Cables to be terminated at both ends and provided a 24" service coil where the conduit stubs above the ceiling and a total of 25' slack in the IT room.

5. Where applicable, all structured cabling shall be installed in a basket-style cable tray system. Cable tray shall be sized to provide an additional 50% capacity after final design cabling is installed.

I. OTHER CABLING

1. Provide 24AWG – (2) conductor paging circuits as required throughout the facility. At a minimum provide paging throughout the main garage, along the exterior of the building and interior office/break-room/corridor areas.

2. Provide security system, fire alarm and additional low voltage system cabling as required by local codes and system design.

J. FACILITY CABLING REQUIREMENTS

1. Each ancillary building located on the campus shall have (2) 2" conduits provided from the main communications room located in the main building. One shall be dedicated for network connectivity and the other for security system cabling.

2. Each building shall be provided adequate wall space to house a small wall mount cabinet (24Dx24Wx24H) Provided by the installer, and termination space for the security system cabling. Each location shall have a dedicated power circuit connected to the main buildings distribution.

3. Each building shall be provided a 6-strand fiber optic cable and 25-pair cable from the main communications room located in the main building. All fiber shall be terminated in a rack mount fiber optic LIU.

4. Gas pumps shall be provided a 1" conduit from the main communications room with (1) Cat-6 cable. Pump locations beyond UTP distance limits of 295' shall be provided a 6-strand multi-mode fiber optic cable. Fiber and/or copper will be terminated at each end in the Fuel Master Unit by the Technology Contractor when it get installed.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

C. The structure cabling system shall be provided with a 25 year manufacturer's warranty.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
2. Wiring diagrams to show typical wiring schematics, including the following:

a. Cross-connects.
b. Patch panels.
c. Patch cords.

3. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site. Test each pair of UTP cable for open and short circuits.

PART 2 - PRODUCTS

A. The following sections list materials and products acceptable for this project. Bidders may submit other products for consideration as equals by sending a request to the Engineer in writing no less than 10 days prior to the bid date. Include manufacturer cut sheets and any other information required to evaluate requested substitution. If the proposed substitution is accepted, it will be added by addendum, allowing all bidders the option to use that equipment.

B. ITEMS NOT SPECIFICALLY ADDED BY ADDENDUM WILL NOT BE ACCEPTED.

2.2 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.

1. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
2. Bridged taps and splices shall not be installed in the horizontal cabling.

2.3 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in ANSI/TIA-568-D when tested according to test procedures of this standard.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Grounding: Comply with ANSI/TIA-607-D.

2.4 UTP CABLE

A. Provide Category-6 horizontal cabling as required to provide connectivity as shown on the Technology plans.

B. All Cat-6 horizontal cabling shall be Category-6 UTP, 4 Pair, 23/24 AWG, solid conductor cable.

C. The cable jackets shall be clearly marked from the factory indicating the Category listing, plenum rating, and linear footage of cable from spool.

D. The 4 pair UTP cable shall be UL□ and c (UL□) Listed Type CMP (plenum).

E. White cable shall be provided for all voice outlets, blue cable shall be provided for all data outlets.

F. The Category 6 cabling shall meet the Cat6 minimum standards as listed by ANSI/EIA/TIA.

G. Design Basis- Category 6 products are Siemon 9C6-E2-02-RXA (White) and Siemon 9C6-E2-06-RXA (Blue), or equal by Ortronics, Commscope and Panduit.

2.5 UTP CABLE FOR WIRELESS ACCESS POINTS

A. Description: 100-ohm, four-pair UTP covered with a thermoplastic jacket, color as noted on the drawings.

1. Shall be Systimax 2091, yellow in color.
2. Comply with ICEA S-90-661 for mechanical properties.
3. Comply with ANSI/TIA-568-D for performance specifications.
4. Comply with ANSI/TIA-568-D, Category 6.
5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

   a. Communications, General Purpose: Type CM or CMG.
   b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
   c. Communications, Riser Rated: Type CMR, complying with UL 1666.

2.6 STP CABLE FOR AUDIO-VISUAL SYSTEMS

A. Description: 100-ohm, four-pair STP covered with a thermoplastic jacket, color as noted on the drawings.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with ANSI/TIA-568-D for performance specifications.
3. Comply with ANSI/TIA-568-D, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

   a. Communications, General Purpose: Type CM or CMG.
   b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
   c. Communications, Riser Rated: Type CMR, complying with UL 1666.

2.7 UTP CABLE HARDWARE

A. General Requirements for Cable Connecting Hardware: Comply with ANSI/TIA-568-D, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

B. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated, plus 25% spare positions.

C. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

D. Patch Cords: Factory-made, four-pair cables in 36-inch (900 mm), 48-inch1200-mm, and 84-inch 2100-mm lengths; terminated with eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

2.8 CAT-6 OUTLETS

A. All Category-6 UTP cables shall terminate at the station end in an 8-pin RJ45 outlet with TIA-568B wiring configuration. Jacks at station end shall be modular jacks with appropriate faceplate containing labeling slot.

B. All Category-6 outlets shall meet or exceed Category-6 transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA-568 Commercial Building Telecommunications Cabling Standard, Horizontal Cable Section, and be part of the UL LAN Certification and Follow-up Program.

C. The Category-6 outlets shall be capable of being in a modular patching situation or as a modular telecommunication outlet (TO) supporting current 10Base-T, 100BASE-T, Token Ring,100 Mbps TP-PMD, 155 Mbps ATM, 622 Mbps ATM using parallel transmission schemes and high-speed, high-bandwidth applications, including Ethernet 1000BASE-T and 1.2 Gbps ATM.

D. Design Basis: Angled Category 6 outlets –Siemon MX6-02 White and Siemon MX6-06 Blue or equals by Ortronics Commscope and Panduit.

2.9 FACEPLATES

A. All faceplates shall be telco ivory or office white in color and be designed to mount the modular outlets supplied.

B. Data/Voice faceplates shall contain (4) four module positions minimum for single gang plates. Faceplates shall have recessed label holders with clear plastic protective cover.

C. Wall outlets indicated for wall-mounted phones shall be recessed and contain a standard 2-pin hanger support for wall phone mounting.

D. Design Basis Faceplates: Data/Voice Single Gang –Siemon MX-FP-S-04-02 or equal by Ortronics Commscope or Panduit.

E. Design Basis Faceplates: Wall mounted telephone –Siemon or equal by Ortronics Siemon, Commscope or Panduit.

F. Design Basis Blank Inserts –Ortronics OR-42100002 or equal by Siemon, Commscope or Panduit.

2.10 CAT6 UTP PATCH PANELS

A. Horizontal patch panels shall be provided as shown on the System Schematics and the Rack/Cabinet Elevations.

B. Category-6 UTP horizontal cables shall terminate at the ER and TRs in an 8-pin, Cat-6, RJ45 connector with TIA-568B wiring configuration in a high density patch panel.

C. Patch panels shall be 48-port minimum to allow installation of wire managers above and below panel for organized patching.

D. Patch panels shall contain rear cable management bracket for guiding cables and providing strain relief at connection. Patch panels shall contain labeling window fields above outlets. Colored factory labeling strips or colored tag indicators attached to patch panels are acceptable.

E. All ports on the patch panels shall be filled with Cat-6 outlets.

F. Separate patch panels shall be provided for each type of Cat-6 horizontal cables (Voice and Data in the quantities shown on the Rack/Cabinet elevations.

G. Design Basis UTP Patch Panel: Siemon HD6-48 or equal by Ortronics, Commscope or Panduit.

2.11 HORIZONTAL CABLE MANAGEMENT

A. Provide horizontal cable organizers as shown on the Rack/Cabinet Elevations.

B. Cable organizers shall have a black powder coat finish and be constructed of 16 ga. steel, provide seven management rings, six pass through holes, have a front ring depth of 3.5” and have a hinged front cover.

C. Design Basis 2 RU Cable Organizers –Siemon RS-RWM-2 or equal by Ortronics, Commscope or Panduit.

2.12 PATCH CORDS

A. Provide all Cat-6 and fiber optic patch cords required to provide all voice, data and backbone connections as shown on the plans and details.

B. Category 6 patch cords.

1. All Cat-6 patch cords shall be supplied by the same manufacturer as the UTP connectivity. Provide one patch cable for every outlet at the station end and one patch cable for every outlet at the TR end.

2. Provide 3' patch cords within the TR. Provide 10’ patch cables for all station outlets.

3. Provide patch cable lengths as required to neatly route cables from the patch panel port to the network switch port without excessive webbing of unused length.

4. Patch cables shall be supplied in the following colors based on use: Voice – White, Data – Blue.

5. Design Basis Cat 6 Patch Cords –Siemon MC6-8-T-XX-XX or equal by Ortronics Siemon, Commscope or Panduit.

2.13 HANGERS AND SUPPORTS

A. J-HOOKS

1. In areas of the building not being provided with cable tray or conduits stubbed out to the cable tray provide J-Hooks as required for proper cable support.

2. J-Hooks shall be specifically designed for interior use with data cables.

3. J-Hooks shall be provided as required with all of the manufacturer's recommended installation hardware for the installation application.

4. Approved J-Hook manufacturers are B-Line, Caddy, Hoffman, Panduit or Arlington.

B. BRIDLE RINGS

1. Bridle rings shall be made of steel, rated for indoor use in non-corrosive environments.

2. Bridle rings shall be UL listed.

3. Shall have an ultimate static load limit of 50 lbs.

4. Shall be able to be assembled to manufacturer recommended specialty fasteners for connection to building structures like beam, drop wire/rod, purlin, wood structure, concrete and acoustical tee grid.

5. Under no circumstance shall bridle rings be used to support any data or voice cable.

2.14 DEMARC EXTENSION

A. Service entrance facilities will be installed by the owner's service provider. In the event that The service provider's demarcation is in a different location that the main Technology room, both Fiber optic cable and Multi-pair cable will be installed by the service provider to the main Technology Room. The 271500 Contractor shall be required to extend a 12 strand multimode fiber optic cable and a 25 pair copper cable from the Demarc to the Technology Data Rack.

1. Wall mounted Fiber Interconnect Center shall support a minimum of 12 multimode fiber optic terminations, and include bend radius guides for proper storage of fiber strands, include dust proof grommets and have a black powder coat finish.

a. Design Basis Wall mounted fiber interconnect center: Siemon SWIC3-M-01 orequal by Ortronics, Commscope or Panduit

2. Rack mounted Fiber Interconnect Center shall support a minimum of 12 multimode fiber optic terminations, and include bend radius guides for proper storage of fiber strands, sliding tray, label holders and have a black power coat finish

a. Design Basis. Siemon FCP3-DWR or equal by Ortronics, Commscope or Panduit.

3. Plug and Play modules shall be 6 port SC style modules in black color

a. Design Basis. Siemon PP6-SC6MM01 or equal by Ortronics, Commscope or Panduit.

4. Plug and Play 62.5/125 pre terminated, 12 strand Multimode Fiber Optic Plenum cable.

a. Design Basis. Siemon FR12-6MMP-XXX or equal by Ortronics, CommScope or Panduit.

5. Cat 3, 50 pair, Plenum rated copper cable.

a. Design Basis. Superior Essex, General, Belden.

6. 110-100 pair termination block with legs, C-5 clips, plastic label window and labels.

a. Design Basis. Siemon S110AA2-100FT or equal by Ortronics, CommScope or Panduit.

7. Rack mounted 24 port patch panel with universal pin assignments. Terminate 2 pair per patch panel port.

a. Design Basis. Siemon HD5-24 or equal by Ortronics, Commscope or Panduit.

2.15 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with ANSI/TIA-607-D.

2.16 IDENTIFICATION PRODUCTS

A. Comply with ANSI/TIA-606-C and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

2.17 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP cables on reels according to ANSI/TIA-568-D.

C. Factory test UTP cables according to ANSI/TIA-568-D.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate cabling with the demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters. Conceal pathways and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements in Section 270528 "Pathways for Communications Systems."
3. Comply with requirements in Section 270536 "Cable Trays for Communications Systems."

B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures:

1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Install lacing bars and distribution spools.
3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with ANSI/TIA-568-D.
2. Install 110-style IDC termination hardware unless otherwise indicated.
3. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
9. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.

C. UTP Cable Installation:

1. Comply with ANSI/TIA-568-D.
2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Separation from EMI Sources:

1. Comply with ANSI/TIA-569-E for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with ANSI/TIA-569-E.

3.5 GROUNDING

A. Comply with ANSI/TIA-607-D.

B. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar.

C. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with ANSI/TIA-606-C. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Administration Class: 1.
2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of ANSI/TIA-606-C. Furnish electronic record of all drawings, in software and format selected by Owner.

E. Cable and Wire Identification:

1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in ANSI/TIA-606-C.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Visually inspect UTP jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with ANSI/TIA-568-D.
2. Visually confirm Category 6 marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in ANSI/TIA-568-D. Perform tests with a tester that complies with performance requirements. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

5. UTP Performance Tests:

    a. Test for each outlet. Perform the following tests according to ANSI/TIA-568-D and ANSI/TIA-568-D:

        1) Wire map.
        2) Length (physical vs. electrical, and length requirements).

3) Insertion loss.
4) Near-end crosstalk (NEXT) loss.
5) Power sum near-end crosstalk (PSNEXT) loss.
6) Equal-level far-end crosstalk (ELFEXT).
7) Power sum equal-level far-end crosstalk (PSELFEXT).
8) Return loss.
9) Propagation delay.
10) Delay skew.

6. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.

a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

B. Document data for each measurement. Data for submittals shall be printed in a summary report, or transferred from the instrument to the computer and printed and submitted.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets.

END OF SECTION 271500

SECTION 281300 - ACCESS CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Security access central-control station.
2. One or more security access networked workstations.
3. Security access operating system and application software.
4. Security access controllers connected to high-speed electronic-data transmission network.

1.2 DEFINITIONS

A. Credential: Data assigned to an entity and used to identify that entity.

B. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.

C. Identifier: A credential card, keypad personal identification number or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

D. Location: A Location on the network having a PC-to-controller communications link, with additional Controllers at the Location connected to the PC-to-controller link with TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.

E. PCI Bus: Peripheral Component Interconnect. A peripheral bus providing a high-speed data path between the CPU and peripheral devices such as monitor, disk drive, or network.

F. RAS: Remote access services.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Comply with SIA BIO-01.

B. Shop Drawings:

1. Diagrams for cable management system.
2. System labeling schedules.
3. Wiring diagrams.
4. Cable administration drawings.
5. Battery and charger calculations for central station, workstations, and controllers.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

A. Operation and maintenance data include the following:

1. Software documentation.
2. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.
3. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.
4. System installation and setup guides with data forms to plan and record options and setup decisions.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70, "National Electrical Code."

C. Comply with SIA DC-03 and SIA DC-07.

1.7 PROJECT CONDITIONS

A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F (16 to 30 deg C) and a relative humidity of 20 to 80 percent, noncondensing.
2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except central-station control unit, installed in temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
3. Indoor, Uncontrolled Environment: NEMA 250, Type 3R enclosures. System components installed in non-temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.

1.8 DESCRIPTION

A. The Contractor is responsible for the Work described in this Section and shall coordinate their work with specification section 282400.

B. Provide an intrusion detection and access control system as described in the specifications and shown on the project drawings.

C. Provide wiring for one (1) telephone line to provide for off-site monitoring and one (1) network connection for LAN/WAN communication with the 281500 system.

D. Program system so that all system information is complete and individual alpha-numeric device/zone information is available for administrative use and also for off-site monitoring.

2.1 ACCESS CONTROL PANEL

A. The access control panel shall include the following capabilities:

1. Grant or deny access to any door controlled by the system based on card holder privileges.

2. Network communication.

3. Communicate with all field deployed devices such as door contacts, card readers, etc.

4. Integrate with other security systems including but not limited to intrusion detection panels and CCTV systems.

5. Graphical Map creation and usage, with device icons for all 281500 and 282400 devices.

6. System shall provide detailed reports and system administration capabilities.

7. All programming and system administration shall be performed from any workstation by personnel with proper access and permissions.

B. Approved Access Control Panel: S2 Netbox Enterprise – no substitutions.

2.2 CARD READERS, CARDS, AND INTERCOMS

A. Provide card readers for each door controlled by the access control system as shown on the drawings.

B. Provide card readers and intercoms at vehicle gate locations as shown on the drawings. The gate control card readers and intercoms shall be installed on dual-height gooseneck pedestals provided by security vendor.

2.3 ELECTRONIC LOCKS

A. Electronic locks shall be provided by others. Coordinate with door hardware schedule for electronic lock details.

2.4 REQUEST-TO-EXIT (REX)

A. Provide REX hardware for each access controlled door shown on the drawings. The 281500 contractor shall ensure REX signaling is used on all access controlled doors.

2.5 POWER SUPPLIES

A. Provide power supplies to power all equipment associated with the system including electronic locks.

.B. Coordinate with door hardware schedule for electronic lock details. Ensure electronic lock power supplies are sized for the loads served including power drop over distance etc.

2.6 INTRUSION DETECTION PANEL

A. The Intrusion Detection Panel shall include the following capabilities:

1. Battery backup coverage shall be provided.

2. Respond to all alarm events from all field deployed devices such as door contacts, motion detectors etc.

3. Full integration with the Access Control System.

4. Full reporting of all events with an off-site monitoring company.

B. Approved Intrusion Detection Panel: DMP – no substitutions.

2.7 KEYPADS

A. Provide keypads at locations as shown of drawings.

B. Keypads shall provide a 32-character alpha-numeric display.

C. Approved Keypad: DMP

2.8 DOOR CONTACTS

A. Provide door contacts at locations as shown on the drawings.

B. Door contacts on personnel doors shall be ¾” recessed.

C. Provide overhead door contacts at applicable overhead door locations.

2.9 MOTION DETECTORS

A. Provide motion detectors at locations as shown on drawings.

B. All motion detectors shall be dual technology.

C. All motion detectors shall be adjustable for mounting height, pulse count, and sensitivity.

2.10 SYSTEM SOFTWARE

A. The system shall utilize a browser based web appliance architecture.

B. The web server shall be contained in the door controllers which are network edge devices.

C. All interface with the system shall be through a web browser.

D. The system shall be capable of communication with all door controllers, integrated intrusion detection panels and devices, and the CCTV system (282400). Provide all licensing and options for full integration with the intrusion detection and CCTV systems.

E. Provide full programming of system including all access control and intrusion detection devices, and CCTV system integration.

F. Licenses shall be provided for all doors/controllers and features associated with this project including integration with the CCTV system.

G. Approved System Software: S2 – no substitutions.

2.11 CABLES

A. Provide as required by the manufacturer's specifications the following plenum cables. Ensure cable gage is sized appropriately for load served at all locations.

1. RS-232: Plenum, 2 pairs, 22 AWG stranded, with foil shield

2. RS-485: Plenum, 2 pairs, 22 AWG stranded

3. Proximity Card Readers: Plenum, 6 conductors, 22 AWG stranded, with foil shield

4. Keypads: Plenum, 4 conductors, 22 AWG stranded

5. Electronic Lock: Plenum, 2 conductors, 14 to 18 AWG stranded

6. Motion Detectors: Plenum, 4 conductors, 22 AWG stranded

7. Request-To-Exit: Plenum, 4 conductors, 22 AWG stranded

8. Door Contacts: Plenum, 2 conductors, 22 AWG stranded

9. Miscellaneous Alarm Inputs: Plenum, 2 conductors, 22 AWG stranded

B. Approved Cable Manufacturers: Belden, West-Penn, or General.

2.12 CONDUIT

A. All cabling for each device and/or location shall be contained in 1” (minimum) conduit.

B. Each conduit run shall be installed with a pull wire for use in cable installation.

PART 3 - EXECUTION

3.1 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. Comply with ANSI/TIA-606-D, "Administration Standard for Commercial Telecommunications Infrastructure."

C. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.

1. Record setup data for control station and workstations.
2. For each Location, record setup of controller features and access requirements.
3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
4. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
5. Assign action message names and compose messages.
6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
7. Prepare and install alarm graphic maps.
8. Develop user-defined fields.
9. Develop screen layout formats.
10. Propose setups for guard tours and key control.
11. Discuss badge layout options; design badges.
12. Complete system diagnostics and operation verification.
13. Prepare a specific plan for system testing, startup, and demonstration.
14. Develop acceptance test concept and, on approval, develop specifics of the test.
15. Develop cable and asset-management system details; input data from construction documents. Include system schematics and Visio Technical Drawings in electronic format.

D. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

3.2 CABLING

A. Comply with NECA 1, "Good Workmanship in Electrical Construction."

B. Install cables and wiring according to requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security."

C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental airspaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.

E. Install LAN cables using techniques, practices, and methods that are consistent with Category 6 rating of components and fiber-optic rating of components, and that ensure Category 6 and fiber-optic performance of completed and linked signal paths, end to end.

F. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

G. Install end-of-line resistors at the field device location and not at the controller or panel location.

3.3 CABLE APPLICATION

A. Comply with ANSI/TIA-569-E, "Commercial Building Standard for Telecommunications Pathways and Spaces."

B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

C. TIA 485-A Cabling: Install at a maximum distance of 4000 ft. (1220 m).

D. Card Readers and Keypads:

1. Install number of conductor pairs recommended by manufacturer for the functions specified.
2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft. (75 m), and install No. 20 AWG wire if maximum distance is 500 ft. (150 m).

3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

E. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed **500 ft. (150 m)**.

F. Install minimum No. 18 AWG ac power wire from transformer to controller, with a maximum distance of **25 ft. (8 m)**.

3.4 GROUNDING

A. Comply with Section 280526 "Grounding and Bonding for Electronic Safety and Security."

B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drain conductors to ground at only one point in each circuit.

E. Signal Ground:

1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
2. Bus: Mount on wall of main equipment room with standoff insulators.
3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.5 INSTALLATION

A. Push Buttons: Where multiple push buttons are housed within a single switch enclosure, they shall be stacked vertically with each push-button switch labeled with 1/4-inch- (6.4-mm-) high text and symbols as required. Push-button switches shall be connected to the controller associated with the portal to which they are applied, and shall operate the appropriate electric strike, electric bolt, or other facility release device.

B. Install card readers, keypads, push buttons, and biometric readers.

3.6 IDENTIFICATION

A. In addition to requirements in this article, comply with applicable requirements in Section 260553 "Identification for Electrical Systems" and with ANSI/TIA-606-D.

B. Develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.

C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

D. At completion, cable and asset management software shall reflect as-built conditions.

3.7 SYSTEM SOFTWARE AND HARDWARE

A. Develop, install, and test software and hardware, and perform databases tests for the complete and proper operation of systems involved. Assign software license to Owner.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Test for faulty connectors, splices, and terminations. Test according to ANSI/TIA-568-D. Link performance for UTP cables must comply with minimum criteria in ANSI/TIA-568-D.
2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated

battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.

3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

C. Devices and circuits will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.9 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service.

1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.10 PROTECTION

A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and.

3.11 DEMONSTRATION

A. **Train** Owner's maintenance personnel to adjust, operate, and maintain security access system. See Section 017900 "Demonstration and Training."

B. Develop separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
3. Security personnel.
4. Hardware maintenance personnel.
5. Corporate management.

END OF SECTION 281300

SECTION 282300 – IP VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes a video surveillance system consisting of cameras, video management server and software, client work station with software, installation, configuration, and licensing. Network electronics shall be provided by the Owner. Cabling and terminations shall be provided in accordance with Division 27, Communications.

B. Related Sections

1. Section 280513 "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with security devices.
2. Section 280528 “Pathways and Electronic Safety and Security” for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.
3. Section 271500 "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

1.2 DESCRIPTION

A. The surveillance system shall be a new IP CCTV surveillance system with digital storage of surveillance video. New cameras, digital storage, and control devices shall be provided, installed, and configured by the Contractor. New client workstation/monitoring location shall be provided at Reception (Room 103).

B. It shall be the responsibility of the Contractor to provide all surveillance system devices, cabling, programming, and configuration necessary for a complete, fully functional surveillance system in accordance with the drawings and specifications.

C. The work to be performed include the provision of all labor, materials, equipment, tools, supervision and integration services required for the proper completion of the installation and commissioning of the surveillance system.

D. The IP CCTV surveillance system shall be integrated with the access control software system, allowing for one, unified security platform.

1.3 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: System components installed in interior environments shall be rated for continuous operation in ambient temperatures of 32 to 122 deg F (0 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
2. Interior, Controlled Environment: System components, except central-station control unit, installed in interior environments shall be rated for continuous operation in ambient temperatures of 32 to 122 deg F (0 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
3. Interior, Uncontrolled Environment: System components installed in non-temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of minus 30 to 122 deg F (minus 18 to plus 50 deg C)] dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 3R enclosures.
4. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h). Use NEMA 250, Type 3R enclosures.
5. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
6. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

1.4 ACTION SUBMITTALS

A. Product Data: For each product indicated. Include product data sheets with dimensions and equipment features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and each field connection.
2. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
3. Functional Block Diagram: Show single-line interconnections between components for signal and control transmission. Show cable types and sizes.
4. Wiring Diagrams: For power, signal, and control wiring.

C. Equipment List: Include every piece of equipment by model number, manufacturer, location, and date of original installation.

D. Field quality-control reports.

E. Operation and maintenance data.

1.5 QUALITY ASSURANCE SUBMITTALS

A. Test Procedures: Test procedures shall explain, in detail, step-by-step actions and expected results demonstrating compliance with the requirements of the specification. Test reports shall be used to document results of ALL tests including field verification testing, performance testing, endurance testing, and acceptance testing. Reports shall be delivered to the Construction Manager within 3 days after completion of each test. Do not proceed to the next stage of testing without written approval of the Construction Manager.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cameras, distribution equipment, and recording equipment to include operation, and maintenance manuals. In addition include the following:

1. System configuration and equipment physical layout.
2. Functional description of equipment.
3. Instructions on operation, adjustment and cleaning.
4. Illustrations and diagrams to supplement procedures.
5. Manufacturer's operation instructions.

B. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace cameras, equipment related to the surveillance system network, digital storage equipment, and control-station equipment that fail within specified warranty period.

B. Warranty Period: One year from date of Substantial Completion.

C. Manufacturer warrantees and extended warrantees shall be conveyed to the owner at the time of acceptance.

D. Installer will prepare and submit warrantee filings in sufficient time to present proof of warrantee at the final acceptance inspection.

PART 2 - PRODUCTS

2.1 CAMERAS

A. Provide cameras at locations as shown on the drawings.

B. All cameras shall be IP based and capable of operating in various light levels and types.

C. The cameras shall have the following minimum characteristics:

1. Auto Iris
2. Backlight Compensation
3. Weatherized/Ruggedized Housing (exterior)
4. 720p resolution
5. Vari-Focal lens

2.2 CCTV SERVERS

The CCTV system shall be provided with CCTV server(s) for the recording and storage of the associated system cameras.

The CCTV server(s) shall install the system software and perform system programming required. Coordinate with owner for programming details.

The CCTV server(s) shall be provided with the most current performance characteristics available and as coordinated with the system manufacturer's requirements.

The 282400 contractor shall provide a KVM switch if more than one CCTV server is required due to camera quantity.

2.3 CCTV WORKSTATION

A. The CCTV system shall be provided with a workstation for viewing and administration use.

B. The 282400 contractor shall install the system client software on the provided CCTV workstation.

C. The software shall provide for multiple camera matrix views of system cameras.

D. Full system viewing and administrative functions shall be able to be performed from the system workstation and associated software.

E. The CCTV workstation shall be provided with the most current performance characteristics available and as coordinated with the system manufacturer's

requirements.

2.4 SURGE PROTECTION

A. Surge protection shall be provided for each exterior camera to prevent transient voltage surges from damaging head end equipment.

B. The 282400 contractor shall ensure that each surge protection device is properly installed and grounded.

2.5 SYSTEM SOFTWARE

A. The CCTV system shall be a fully IP based system.

B. The CCTV system software shall provide full system administration and viewing capabilities to all who have system access and password privileges.

C. The 282400 contractor shall perform all system programming including camera titles for all cameras, frame rates, compression settings, motion detection field adjustments etc.

D. Licenses shall be provided for all cameras associated with this project, and for all features described including integration with the Access Control and Intrusion Detection system.

E. Approved CCTV System Software: Milestone XProtect Enterprise – no exceptions.

2.6 UPS

A. Provide a UPS for each CCTV Server and each CCTV Workstation.

B. Each UPS shall provide a minimum of 1000VA/700 watts and have a minimum of four (4) outlets.

2.7 CABLES

A. Each camera shall transmit on data cabling provided, certified, and tested by others.

B. The 282400 contractor shall provide all patch cables between all cameras and horizontal cabling, between data patch panels and data switches, and for the CCTV Server(s).

2.8 CONDUIT

A. All cabling for each device and/or location shall be contained in 1” (minimum) conduit.

B. Each conduit run shall be installed with a pull wire for use in cable installation.

PART 3 - EXECUTION

3.1 COORDINATION

A. The Security Integrator shall coordinate layout and installation of surveillance equipment with the Construction Manager, Owner's telecommunications staff, networking staff, and service suppliers.

1. It is the Security Integrator's responsibility to schedule and document the video surveillance system equipment coordination meetings prior to the installation of new equipment or devices.
2. Video surveillance system commissioning shall be by the Security Integrator and coordinated with Construction Manager.
3. Record agreements reached in meetings and distribute them to other participants.
4. Adjust arrangements and locations of equipment to optimize the equipment's effectiveness.

B. Coordinate location of power raceways and receptacles with locations of video surveillance system equipment requiring electrical power to operate.

2.8 EXAMINATION

A. The Security Integrator shall make arrangements with the Construction Manager to examine the existing conditions and system equipment spaces.

B. The Security Integrator shall examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

2.9 WIRING

A. The Construction Manager shall provide all conduit and outlet boxes required for a complete system as described herein and as indicated on the drawings.

B. All cabling shall be installed in cable tray provided in corridors and in conduit elsewhere.

C. Wiring Method: Install cables in raceways unless otherwise indicated.

D. Wiring within Enclosures: Bundled, laced, and trained to terminal points without exceeding manufacturer's limitations on bending radii. Provided with and using lacing bars and distribution spools.

E. For LAN connection and copper communication wiring, comply with Section 271500 "Communications Horizontal Cabling."

F. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

2.10 VIDEO SURVEILLANCE SYSTEM INSTALLATION

A. The Contractor shall furnish the services of a factory trained technician to supervise the installation of the system. The equipment manufacturer shall furnish technical assistance to the installing contractor. Make the final connections between equipment and the wiring system under the direct supervision of the factory trained technician.

B. The installed location of all equipment shall be coordinated at the site. Review locations of all equipment PRIOR to commencing the installation.

C. Make necessary adjustments to equipment locations within the facility and install all equipment to allow for the site conditions in the building without additional cost to the Owner.

D. Install cameras level and plumb.

E. Install cameras with 102-inch (2592-mm) minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.

F. Connect all controls and alarms, and adjust.

G. Install power supplies and other auxiliary components unless otherwise indicated.

H. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Identification for Electrical Systems."

2.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.

2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:

a. Verify operation of auto-iris lenses.
b. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
c. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
d. Set sensitivity of motion detection.
e. Connect and verify responses to alarms.
f. Verify operation of control-station equipment.

3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.

4. Operational Tests: Perform operational system tests as specified in Paragraph 3.12 Operational Tests to verify that system complies with Specifications. Include all modes of system operation.

C. Video surveillance system will be considered defective if it does not pass tests and inspections.

D. Prepare and submit test and inspection reports.

2.12 OPERATIONAL TESTS

A. General: Provide all personnel, equipment, instrumentation, and supplies necessary to perform all site testing. Written permission shall be obtained from the Construction Manager before proceeding with the next phase of testing. Original copies of all test data produced during performance verification and endurance testing shall be turned over to the Construction Manager and Engineer at the conclusion of each phase of testing prior to Owner's approval of the test.

B. Integrator's Field Testing (pre-testing): Calibrate and test all equipment, verify transmission media operation, place the integrated system in service, and test the integrated system. Deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Owner that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure. Submit a letter certifying that the video surveillance system equipment is ready for performance verification testing. The field testing shall, as a minimum, include:

1. Verification that the video transmission system and any signal or control cabling have been installed, tested, and approved as specified.
2. Verification that the remote devices are functional, communicate with the security center, and perform all functions as specified.

3. Verification that the video management software has been programmed as needed for the site configuration.
4. Verification that the video management software is functioning correctly. All software functions shall be exercised.
5. Verification that all video sources and video outputs provide a full bandwidth signal at all video inputs.
6. Verification that all cameras are aimed and focused properly. Conduct a walk test of the area covered by each camera to verify the field of view.
7. If vehicles are used in proximity of the assessment areas, verification of night assessment capabilities and determination if headlights cause blooming or picture degradation.
8. Verification that all cameras are synchronized and that the picture is not distorted when cameras are switched.
9. Verification that alarm interfaces are functional and that automatic camera call-up is functional with appropriate video annotation for all designated alarm points and cameras.
10. Verification of all controls for pan/tilt or zoom mechanisms are operative and that the controls perform the desired function. If preposition controls are used, verification that all home positions have been set correctly, and have been tested for auto home function and correct home position.
11. Verify that all preset positions are correct and that the dome also operates correctly in a manual control mode.

C. Performance Verification Test: Demonstrate that the completed video surveillance system equipment complies with the contract requirements. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown. The performance verification test, as specified, shall not be started until approval of the pre-testing submittal has been received. This shall include certification of successful completion of Integrator Field Testing as specified in paragraph "Integrator's Field Testing," and upon successful completion of training as specified.

2.13 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

2.14 TRAINING AND DEMONSTRATION

A. Provide manufacturer's training for the Owner's maintenance personnel to adjust and maintain video-surveillance equipment.

B. Train Owner's administrative and security staff to operate video-surveillance equipment.

2.15 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not necessarily limited to, the following:

1. Check cable connections.
2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
3. Adjust all preset positions; consult Owner's personnel.
4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
5. Provide a written report of adjustments and recommendations.

B. Include the cost of Occupancy Adjustments in the base bid.

END OF SECTION 28 23 00

SECTION 284621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Addressable fire-alarm system.
2. Fire-alarm control unit (FACU).
3. Manual fire-alarm boxes.
4. System smoke detectors.
5. Duct smoke detectors.
6. Heat detectors.
7. Fire-alarm notification appliances.
8. Emergency responder radio coverage system.
9. Fire-alarm remote annunciators.
10. Fire-alarm addressable interface devices.
11. Digital alarm communicator transmitters (DACTs).

B. Related Requirements:

1. Section 087100 "Door Hardware" for magnetic door holders that release in response to fire-alarm outputs.
2. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" or Section 260523 "Control Voltage Electrical Power Cables" for cables and conductors for fire-alarm systems.

1.2 DEFINITIONS

A. DACT: Digital alarm communicator transmitter.

B. FACU: Fire-alarm control unit.

C. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:

1. Control Voltage: Listed and labeled for use in remote-control, signaling, and power-limited circuits supplied by a Class 2 or Class 3 power supply having rated output not greater than 150 V and 5 A, allowing use of alternate wiring methods complying with NFPA 70, Article 725.
2. Low Voltage: Listed and labeled for use in circuits supplied by a Class 1 or other power supply having rated output not greater than 1000 V, requiring use of wiring methods complying with NFPA 70, Article 300, Part I.

1.3 SEQUENCING AND SCHEDULING

A. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.4 ACTION SUBMITTALS

A. Approved Permit Submittal: Submittals must be approved by authorities having jurisdiction prior to submitting them to Architect.

B. Product Data: For each type of product, including furnished options and accessories.

1. Include construction details, material descriptions, dimensions, profiles, and finishes.
2. Include rated capacities, operating characteristics, and electrical characteristics.

C. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in "Documentation" section of "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, and details, including details of attachments to other Work.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include performance parameters and installation details for each detector.
9. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
10. Provide control wiring diagrams for fire-alarm interface to HVAC; coordinate location of duct smoke detectors and access to them.

    a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
    b. Show field wiring and equipment required for HVAC unit shutdown on alarm.
    c. Locate detectors in accordance with manufacturer's written instructions.

11. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

D. Delegated Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.

1. Drawings showing location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of device.
2. Design Calculations: Calculate requirements for selecting spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.

1.5 INFORMATIONAL SUBMITTALS

A. Certificates:

1. Seismic Performance Certificates: For FACU, accessories, and components, from manufacturer. Include the following information:

a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
c. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

B. Field quality-control reports.

C. Qualification Statements: For Installer.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:

a. Comply with "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
b. Provide "Fire-Alarm Record of Completion Documents" in accordance with "Completion Documents" Article in "Documentation" section of "Fundamentals" chapter in NFPA 72.
c. Complete wiring diagrams showing connections between devices and equipment. Each conductor must be numbered at every junction point with indication of origination and termination points.
d. Riser diagram.
e. Device addresses.
f. Record copy of site-specific software.
g. Provide "Inspection and Testing Form" in accordance with "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

1) Equipment tested.

2) Frequency of testing of installed components.
3) Frequency of inspection of installed components.
4) Requirements and recommendations related to results of maintenance.
5) Manufacturer's user training manuals.

h. Manufacturer's required maintenance related to system warranty requirements.
i. Abbreviated operating instructions for mounting at FACU and each annunciator unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media**.**
3. Device address list.
4. Printout of software application.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to **10** percent of amount installed, but no fewer than one unit.
2. Lamps for Strobe Units: Quantity equal to **10** percent of amount installed, but no fewer than one unit.
3. Smoke Detectors and Heat Detectors: Quantity equal to **10** percent of amount of each type installed, but no fewer than one unit of each type.
4. Detector Bases: Quantity equal to **two** percent of amount of each type installed, but no fewer than one unit of each type.
5. Keys and Tools: One extra set for access to locked or tamper proof components.
6. Audible and Visual Notification Appliances: 10 percent of each type installed.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Personnel must be trained and certified by manufacturer for installation of units required for this Project.
2. Installation must be by personnel certified by NICET as fire-alarm Level II technician.
3. Obtain certification by NRTL in accordance with NFPA 72.
4. Licensed or certified by authorities having jurisdiction.

1.9 FIELD CONDITIONS

A. Seismic Conditions: Unless otherwise indicated on Contract Documents, specified Work in this Section must withstand the seismic hazard design loads determined in accordance with ASCE/SEI 7 for installed elevation above or below grade.

1. The term "withstand" means "unit must remain in place without separation of parts from unit when subjected to specified seismic design loads and unit must be fully operational after seismic event."

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail because of defects in materials or workmanship within specified warranty period.

1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FIRE ALARM CONTROL PANEL

A. The control panel shall contain the following general features:

1. Alarm shall override trouble.

2. Built-in lamp test.

3. Ground fault detection.

4. Alarm and silence switch combined. When a silence switch is activated, the trouble lamp shall be illuminated to indicate the abnormal situation.

5. Momentary switch for resetting the system.

6. All programming or editing of the software program shall be achieved without special equipment and without interrupting the alarm monitoring functions of the control panel.

B. System shall be based on Digital Monitoring Products and shall interface with Digital Monitoring Products intrusion detection system. If an event occurs, the areas below will respond in this manner:

LOCATION	INDICATION
Office Area Pull Station	Alarm
Garage Pull Station (East)	Alarm Garage Pull Stations (North, So
Wall P.I.V. Tamper Switch	Trouble
Sprinkler Riser Tamper Switches	Trouble
Smoke Detector	Alarm

2.2 INITIATING AND ALARM DEVICES

A. Audio/visual alarm horn/strobes in large open areas shall be a minimum of 110 candelas. All other audio/visual alarm horn/strobes shall be a minimum of 30 candelas.

B. ALL strobes shall be synchronized. Provide module and wiring to alarm control panel as required.

2.3 WIRE AND CABLE

A. Furnish only wire recommended by Fire Alarm System Manufacturer.

B. Power-limited, solid or stranded (7 strand minimum) copper, #18 AWG and #14 AWG twisted, shielded or unshielded, color-coded vinyl insulation, black vinyl jacket.

C. Install wiring in conduit, unless concealed above ceiling or otherwise indicated.

D. Provide twisted pair telephone cables as required for digital communicator.

E. Wire and cable used in return air plenums shall be UL 910-listed or installed in conduit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF EQUIPMENT

A. Comply with NECA 305, NFPA 72 and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before other trades have completed cleanup must be replaced.
2. Devices installed, but not yet placed, in service must be protected from construction dust, debris, dirt, moisture, and damage in accordance with manufacturer's written storage instructions.

B. Equipment Floor Mounting: Install FACU on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install seismic bracing. Comply with requirements in Section 270548.16 "Seismic Controls for Communications Systems."

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch (460 mm) centers around full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Equipment Floor and Wall Mounting: Install FACU on finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 270548.16 "Seismic Controls for Communications Systems."

D. Install wall-mounted equipment, with tops of cabinets not more than 78 inch (1980 mm) above finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 270548.16 "Seismic Controls for Communications Systems."

E. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in normal path of egress within 60 inch (1520 mm) of exit doorway.
2. Mount manual fire-alarm box on background of contrasting color.
3. Operable part of manual fire-alarm box must be between 42 and 48 inch (1060 and 1220 mm) above floor level. Devices must be mounted at same height unless otherwise indicated.

F. Smoke- and Heat-Detector Spacing:

1. Comply with "Smoke-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Comply with "Heat-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Smooth ceiling spacing must not exceed 30 ft. (9 m).
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas must be determined in accordance with Annex A in NFPA 72.
5. HVAC: Locate detectors not closer than 36 inch (910 mm) from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inch (300 mm) from lighting fixture and not directly above pendant mounted or indirect lighting.

G. Install cover on each smoke detector that is not placed in service during construction. Cover must remain in place except during system testing. Remove cover prior to system turnover.

H. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend full width of duct. Tubes more than 36 inch (9100 mm) long must be supported at both ends.

1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

I. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

J. Remote Status and Alarm Indicators: Install in visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

K. Audible Alarm-Indicating Devices: Install not less than 6 inch (150 mm) below ceiling. Install bells and horns on flush-mounted back boxes with device-operating mechanism concealed behind grille. Install devices at same height unless otherwise indicated.

L. Visible Alarm-Indicating Devices: Install between 80 and 96” above the finish floor. Install devices at same height unless otherwise indicated.

M. Device Location-Indicating Lights: Locate in public space near device they monitor.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate must be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

3.5 PATHWAYS

A. Pathways above recessed ceilings and in inaccessible locations may be routed exposed.

1. Exposed pathways located less than 96 inch (2440 mm) above floor must be installed in EMT.

B. Pathways must be installed in EMT.

C. Exposed EMT must be painted red enamel.

3.6 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Make addressable connections with supervised interface device to the following devices and systems. Install interface device less than 36 inch (910 mm) from device controlled. Make addressable confirmation connection when such feedback is available at device or system being controlled.

1. Smoke dampers in air ducts of designated HVAC duct systems.
2. Magnetically held-open doors.
3. Electronically locked doors and access gates.
4. Alarm-initiating connection to elevator recall system and components.
5. Supervisory connections at valve supervisory switches.
6. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
7. Supervisory connections at elevator shunt-trip breaker.
8. Supervisory connections at fire-extinguisher locations.
9. Supervisory connections at fire-pump power failure including dead-phase or phase-reversal condition.
10. Supervisory connections at fire-pump engine control panel.

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."

B. Install framed instructions in location visible from FACU.

3.8 GROUNDING

A. Ground FACU and associated circuits in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Ground shielded cables at control panel location only. Insulate shield at device location.

3.9 FIELD QUALITY CONTROL

A. Field tests must be witnessed by Architect and Authorities having Jurisdiction.

B. Administrant for Tests and Inspections:

1. Owner will engage qualified testing agency to administer and perform tests and inspections.

C. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.

a. Inspection must be based on completed record Drawings and system documentation that is required by "Completion Documents, Preparation" table in "Documentation" section of "Fundamentals" chapter in NFPA 72.
b. Comply with "Visual Inspection Frequencies" table in "Inspection" section of "Inspection, Testing and Maintenance" chapter in NFPA 72; retain "Initial/Reacceptance" column and list only installed components.

2. System Testing: Comply with "Test Methods" table in "Testing" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Test audible appliances for public operating mode in accordance with manufacturer's written instructions. Perform test using portable sound-level meter complying with Type 2 requirements in ASA S1.4 Part 1/IEC 61672-1.
4. Test visible appliances for public operating mode in accordance with manufacturer's written instructions.
5. Factory-authorized service representative must prepare "Fire Alarm System Record of Completion" in "Documentation" section of "Fundamentals" chapter in NFPA 72 and "Inspection and Testing Form" in "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.

D. Reacceptance Testing: Perform reacceptance testing to verify proper operation of added or replaced devices and appliances.

E. Fire-alarm system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system. Allow Owner to record training.

3.11 MAINTENANCE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service must include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies must be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections in accordance with "Visual Inspection Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Perform tests in "Test Methods" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per "Testing Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.12 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement must include software support for **two** years.

C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within **two** years from date of Substantial Completion. Upgrading software must include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

END OF SECTION 284621.11

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Removing existing vegetation.
2. Clearing and grubbing.
3. Stripping and stockpiling topsoil.
4. Stripping and stockpiling rock.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing site utilities.
7. Temporary erosion and sedimentation control.

1.3 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.

D. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.

B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated by owner.

C. Utility Locator Service: Notify Call Before You Dig for area where Project is located before site clearing.

D. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.

E. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways,

according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

C. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed.

1. Arrange with utility companies to shut off indicated utilities.

B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify owner not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without owner's written permission.

C. Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections; and in Section 024116 "Structure Demolition" and Section 024119 "Selective Demolition."

3.4 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots larger than 2 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
3. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within protection zones.
3. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.6 STOCKPILING ROCK

A. Remove from area indicated on Drawings naturally formed rocks that measure more than 1 foot across in least dimension. Do not include excavated or crushed rock.

B. Stockpile rock away from edge of excavations without intermixing with other materials. Cover to prevent windblown debris from accumulating among rocks.

1. Limit height of rock stockpiles to 36 inches .
2. Stockpile surplus rock to allow later use by the Owner.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for slabs-on-grade, walks, pavements, and turf and grasses.
3. Excavating and backfilling for buildings and structures.
4. Drainage course for concrete slabs-on-grade.
5. Subbase course for concrete walks, pavements.
6. Subbase course and base course for asphalt paving.
7. Subsurface drainage backfill for walls and trenches.
8. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Requirements:

1. Section 013200 "Construction Progress Documentation" for recording preexcavation and earth-moving progress.
2. Section 311000 "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
3. Section 329200 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.

1.2 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit price.
2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, will be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Rock:

1. Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

   a. Equipment for Footing, Trench, and Pit Excavation: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- maximum-width, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,700 lbf and stick-crowd force of not less than 18,400 lbf with extra-long reach boom.
   b. Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp flywheel power and developing a minimum of 47,992-lbf breakout force with a general-purpose bare bucket.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other fabricated stationary features constructed above or below the ground surface.

J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct preexcavation conference at location agreed upon by all parties. .

1. Review methods and procedures related to earthmoving, including, but not limited to, the following:
   a. Coordination of Work with utility locator service.
   b. Project phasing coordination
   c. Location of construction fencing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Geotextiles.
2. Controlled low-strength material, including design mixture.
3. Geofoam.
4. Warning tapes.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Material Test Reports: For each borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D2487.
2. Laboratory compaction curve according to ASTM D698.

C. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

1.6 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E329 and ASTM D3740 for testing indicated.

1.7 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Utility Locator Service: Notify "Call Before You Dig” for area where Project is located before beginning earth-moving operations.

C. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in Section 311000 "Site Clearing" are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Base Course: refer to ODOT item 304

F. Engineered Fill: refer to ODOT item 203

G. Bedding Course: refer to ODOT item 840

H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and zero to 5 percent passing a No. 8 sieve.

I. Sand: ASTM C33/C33M; fine aggregate.

2.2 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability:
   a. As follows:

      1) Grab Tensile Strength: 157 lbf; ASTM D4632.
      2) Sewn Seam Strength: 142 lbf; ASTM D4632.
      3) Tear Strength: 56 lbf; ASTM D4533.
      4) Puncture Strength: 56 lbf ; ASTM D4833.

   b. Apparent Opening Size: No. 40 sieve, maximum; ASTM D4751.

c. Permittivity: 0.5 per second, minimum; ASTM D4491..
d. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

2.3 CONTROLLED LOW-STRENGTH MATERIAL

A. Refer to ODOT item 613

2.4 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Protect and maintain erosion and sedimentation controls during earth-moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Provide dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

D. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

3.3 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.4 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch . Do not disturb bottom of excavations intended as bearing surfaces.

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.6 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms:

1. Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

a. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.7 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.

B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.8 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.9 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring, bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.11 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 "Cast-in-Place Concrete."

D. Trenches under Roadways: Provide 4-inch- thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 033000 "Cast-in-Place Concrete."

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Initial Backfill:

1. Soil Backfill: Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

   a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

2. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.

G. Final Backfill:

1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
2. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

H. Warning Tape: Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.12 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.13 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.14 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D698

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95percent.

2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.15 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch
2. Walks: Plus or minus 1 inch
3. Pavements: Plus or minus 1/2 inch

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.16 SUBSURFACE DRAINAGE

A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D698 with a minimum of two passes of a plate-type vibratory compactor.

B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D698 with a minimum of two passes of a plate-type vibratory compactor
2. Place and compact impervious fill over drainage backfill in 6-inch- thick compacted layers to final subgrade.

3.17 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

3.18 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches or less in compacted thickness in a single layer.
3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95percent of maximum dry unit weight according to ASTM D698.

3.19 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material classification and maximum lift thickness comply with requirements.
3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

E. Testing agency will test compaction of soils in place according to ASTM D1556, ASTM D2167, ASTM D2937, and ASTM D6938, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.20 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.
1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Hot-mix asphalt paving.
2. Hot-mix asphalt patching.
3. Asphalt surface treatments.

B. Related Requirements:

1. Section 024116 "Structure Demolition"for demolition and removal of existing asphalt pavement.
2. Section 312000 "Earth Moving" for subgrade preparation, fill material, separation geotextiles, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
3. Section 321313 "Concrete Paving" for concrete pavement and for separate concrete curbs, gutters, and driveway aprons.
4. Section 321373 "Concrete Paving Joint Sealants" for joint sealants and fillers at pavement terminations.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to paving including, but not limited to, the following:

a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture asphalt.
b. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

1.4 ACTION SUBMITTALS

A. Hot-Mix Asphalt Designs:

321216 - 1

1. Certification, by authorities having jurisdiction, of approval of each hot-mix asphalt design proposed for the Work.

B. Samples for Verification: For the following product, in manufacturer's standard sizes unless otherwise indicated:

1. Paving Geotextile: 12 by 12 inches minimum.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For paving-mix manufacturer and testing agency.

B. Material Certificates: Per ODOT Construction and material Specification herin referred to as CMS (latest edition)

C. Material Test Reports: For each paving material, by a qualified testing agency

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by ODOT.

B. Testing Agency Qualifications: Qualified in accordance with ASTM D3666 for testing indicated.

C. Regulatory Requirements: Comply with materials, per CMS section 401 except as otherwise directed in this document.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of 60 deg F
2. Tack Coat: Minimum surface temperature of 60 deg F
3. Slurry Coat: Comply with weather limitations in ASTM D3910.
4. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
5. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

321216 - 2

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D692/D692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

C. Fine Aggregate: ASTM D1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: ASTM D242/D242M or AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320 binder designation PG 64-22

B. Asphalt Cement: ASTM D3381/D3381M for viscosity-graded material, ASTM D946/D946M for penetration-graded material.

C. Cutback Prime Coat: ASTM D2027/D2027M, medium-curing cutback asphalt, MC-30 or MC-70.

D. Emulsified Asphalt Prime Coat: ASTM D977 or AASHTO M 140 emulsified asphalt, or ASTM D2397/D2397M or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

E. Tack Coat: ASTM D977 emulsified asphalt, or ASTM D2397/D2397M cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

F. Fog Seal: ASTM D977 emulsified asphalt, or ASTM D2397/D2397M cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.

G. Water: Potable.

H. Undersealing Asphalt: ASTM D3141/D3141M; pumping consistency.

2.3 AUXILIARY MATERIALS

A. Recycled Materials for Asphalt Mixes: Per CMS

321216 - 3

B. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.

C. Sand: ASTM D1073 or AASHTO M 29, Grade No. 2 or No. 3.

D. Paving Geotextile: AASHTO M 288 paving fabric; nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.

E. Joint Sealant: ASTM D6690, Type II or III, hot-applied, single-component, polymer-modified bituminous sealant.

2.4 MIXES

A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes designed in accordance with procedures in AI MS-2, "Asphalt Mix Design Methods"; and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.

B. Emulsified-Asphalt Slurry: ASTM D3910, Type 1.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protection: Provide protective materials, procedures, and worker training to prevent asphalt materials from spilling, coating, or building up on curbs, driveway aprons, manholes, and other surfaces adjacent to the Work.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph
2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

321216 - 4

3.3 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Undersealing: Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Placing Single-Course Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

E. Placing Two-Course Patch Material: Partially fill excavated pavements with hot-mix asphalt base course mix and, while still hot, compact. Cover asphalt base course with compacted layer of hot-mix asphalt surface course, finished flush with adjacent surfaces.

3.4 SURFACE PREPARATION

A. Ensure that prepared subgrade has been proof-rolled and is ready to receive paving. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces.

B. Herbicide Treatment: Apply herbicide in accordance with manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

C. Cutback Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.

321216 - 5

2. Protect primed substrate from damage until ready to receive paving.

D. Emulsified Asphalt Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.10 to 0.30 gal./sq. yd. per inch depth (0.5 to 1.40 L/sq. m per 25 mm depth). Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

E. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.5 HOT-MIX ASPHALT PLACEMENT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at a minimum temperature of 250 deg F
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of mix along longitudinal joints.
2. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

321216 - 6

3.6 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches
3. Offset transverse joints, in successive courses, a minimum of 24 inches
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method in accordance with AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.7 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
1. Average Density, Rice Test Method: 92 percent of reference maximum theoretical density in accordance with ASTM D2041/D2041M, but not less than 90 percent or greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

321216 - 7

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.8 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch
2. Surface Course: Plus 1/4 inch , no minus.

B. Pavement Surface Smoothness: Compact each course to produce surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch .
2. Surface Course: 1/8 inch .

C. Fog Seals: Apply fog seal at a rate of 0.10 to 0.15 gal./sq. yd. to existing asphalt pavement and allow to cure. With fine sand, lightly dust areas receiving excess fog seal.

D. Slurry Seals: Apply slurry coat in a uniform thickness in accordance with ASTM D3910 and allow to cure.

1. Roll slurry seal to remove ridges and provide a uniform, smooth surface.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined in accordance with ASTM D3549/D3549M.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement in accordance with ASTM D979/D979M or AASHTO T 168.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared in accordance with ASTM D2041/D2041M, and compacted in accordance with job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples in accordance with ASTM D1188 or ASTM D2726/D2726M.

   a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than three cores taken.

321216 - 8

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.10 WASTE HANDLING

A. General: Handle asphalt-paving waste in accordance with approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

END OF SECTION 321216

321216 - 9

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes concrete paving

1. Driveways.
2. Parking lots.
3. Curbs and gutters.
4. Walks.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for general building applications of concrete.
2. Section 321373 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.
3. Section 321713 "Parking Bumpers."
4. Section 321723 "Pavement Markings."
5. Section 321726 "Tactile Warning Surfacing" for detectable warning mats

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site

1. Review methods and procedures related to concrete paving, including but not limited to, the following:

   a. Concrete mixture design.
   b. Quality control of concrete materials and concrete paving construction practices.

2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:.

   a. Contractor's superintendent.
   b. Independent testing agency responsible for concrete design mixtures.
   c. Ready-mix concrete manufacturer.
   d. Concrete paving Subcontractor.
   e. Manufacturer's representative of stamped concrete paving system used for stamped detectable warnings.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.

C. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

C. Material Test Reports: For each of the following:

1. Aggregates

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Stamped Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.

B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

C. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests must be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

1.8 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F , uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT.

A. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

B. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A, plain steel.

C. Reinforcing Bars: ASTM A615/A615M, Grade 60; deformed.

D. Galvanized Reinforcing Bars: ASTM A767/A767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A615/A615M, Grade 60 deformed bars.

E. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M; with ASTM A615/A615M, Grade 60 deformed bars.

F. Steel Bar Mats: ASTM A184/A184M; with ASTM A615/A615M, Grade 60 (Grade 420) deformed bars; assembled with clips.

G. Plain-Steel Wire: ASTM A1064/A1064M, galvanized.

H. Deformed-Steel Wire: ASTM A1064/A1064M.

I. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A; coated, deformed.

J. Joint Dowel Bars: ASTM A615/A615M, Grade 60 plain-steel bars; zinc coated galvanized after fabrication according to ASTM A767/A767M, Class I coating. Cut bars true to length with ends square and free of burrs.

K. Epoxy-Coated, Joint Dowel Bars: ASTM A775/A775M; with ASTM A615/A615M, Grade 60 plain-steel bars.

L. Tie Bars: ASTM A615/A615M, Grade 60 deformed.

M. Hook Bolts: ASTM A307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

N. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

O. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

P. Zinc Repair Material: ASTM A780

2.4 CONCRETE MATERIALS

A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C150, gray portland cement Type I/II
2. Fly Ash: ASTM C618, Class F.
3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
4. Blended Hydraulic Cement: ASTM C595/C595M, Type IS, portland blast-furnace slag or Type IP, portland-pozzolan

B. Normal-Weight Aggregates: ASTM C33/C33M, uniformly graded. Provide aggregates from a single source

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:

1. Aggregate Sizes: 3/4 to 1 inch nominal.

D. Air-Entraining Admixture: ASTM C260/C260M.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

F. Water: Potable and complying with ASTM C94/C94M.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry or cotton mats.

B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
   1. Products: subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to the following:
      a. Euclid Chemical Company (The), an RPM Company: Eucobar.
      b. L&M Construction Chemicals, inc.; E-CON
      c. Meadows, w.r. inc.; EVAPRE
      d. Sika Corperation, inc.; SkiaFilm

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.
   1. Products: subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to the following:
      a. Euclid Chemical Company (The), an RPM Company: Kurez W VOX.
      b. L&M Construction Chemicals, inc.; L&M CURE R.
      c. Meadows, w.r. inc.; 1100-CLEAR SERIES

2.6 RELATED MATERIALS

A. Joint Fillers: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork in preformed strips.

B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

C. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy-Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

   1. Types I and II, nonload bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.7 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.

B. Cementitious Materials:Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

.

1. Air Content, 1-1/2-inch (38-mm) Nominal Maximum Aggregate Size: 5-1/2 percent plus or minus 1-1/2 percent.
2. Air Content, 1-inch (25-mm) Nominal Maximum Aggregate Size: 6 percent plus or minus 1-1/2 percent.
3. Air Content, 3/4-inch (19-mm) Nominal Maximum Aggregate Size: 6 percent plus or minus 1-1/2 percent.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture high-range, water-reducing admixture high-range, water-reducing and retarding admixture plasticizing and retarding admixture in concrete as required for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction. Limit vehicle speed to 3 mph .
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 312000 "Earth Moving."

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 INSTALLATION OF STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.

F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D3963/D3963M.

G. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Provide tie bars at sides of paving strips where indicated.
3. Butt Joints: Use epoxy-bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.

4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes..

   a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

   a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.

3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 INSTALLATION OF DETECTABLE WARNINGS

A. Cast-in-Place Detectable Warning Tiles: Form blockouts in concrete for installation of tiles specified in Section 321726 "Tactile Warning Surfacing." Screed surface of concrete where tiles are to be installed to elevation, so that edges of installed tiles will be flush with surrounding

concrete paving. Embed tiles in fresh concrete to comply with Section 321726 "Tactile Warning Surfacing" immediately after screeding concrete surface.

3.9 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.10 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch .
2. Thickness: Plus 3/8 inch, minus 1/4 inch
3. Surface: Gap below 10-feet- long; unleveled straightedge not to exceed 1/2 inch
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch.
6. Vertical Alignment of Dowels: 1/4 inch.

7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch no minus.
10. Joint Width: Plus 1/8 inch no minus.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C172/C172M will be performed according to the following requirements:

.

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd., 5000 sq. ft or fraction thereof of each concrete mixture placed each day.

   a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C231/C231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C39/C39M; test one specimen at seven days and two specimens at 28 days.

   a. A compressive-strength test to be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results to be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests to contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency will make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.12 REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 321373 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold-applied joint sealants.
2. Hot-applied joint sealants.
3. Cold-applied, fuel-resistant joint sealants.
4. Hot-applied, fuel-resistant joint sealants.
5. Joint-sealant backer materials.
6. Primers.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Concrete pavement joint sealants.
2. Joint-sealant backer materials.

B. Paving-Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For Installer and testing agency.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Installers: Entity that employs installers and supervisors who are trained and approved by manufacturer.

1.5 PRECONSTRUCTION TESTING

A. Preconstruction Testing: Performed by a qualified testing agency.

1.6 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain joint sealants from ODOT approved manufacture

2.2 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backer materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.3 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant: ASTM D5893/D5893M, Type NS.

B. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D5893/D5893M, Type SL.

C. Multicomponent, Nonsag, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade NS, Class 25, for Use T.

D. Single Component, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C920, Type S, Grade P, Class 25, for Use T.

E. Multicomponent, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade P, Class 25, for Use T.

2.4 HOT-APPLIED JOINT SEALANTS

A. Hot-Applied, Single-Component Joint Sealant, Type I: ASTM D6690.

B. Hot-Applied, Single-Component Joint Sealant, Type I or Type II: ASTM D6690.

C. Hot-Applied, Single-Component Joint Sealant, Type I, II, or III: ASTM D6690.

D. Hot-Applied, Single-Component Joint Sealant, Type IV: ASTM D6690.

2.5 COLD-APPLIED, FUEL-RESISTANT JOINT SEALANTS

A. Fuel-Resistant, Single-Component, Pourable, Modified-Urethane, Elastomeric Joint Sealant: ASTM C920, Type S, Grade P, Class 25, for Use T.

B. Fuel-Resistant, Multicomponent, Pourable, Modified-Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade P, Class 12-1/2 or 25, for Use T.

2.6 HOT-APPLIED, FUEL-RESISTANT JOINT SEALANTS

A. Hot-Applied, Fuel-Resistant, Single-Component Joint Sealants, Type I or Type II: ASTM D7116.

B. Hot-Applied, Fuel-Resistant, Single-Component Joint Sealants, Type III: ASTM D7116.

2.7 JOINT-SEALANT BACKER MATERIALS

A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.8 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions.

C. Install joint-sealant backers to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of joint-sealant backer materials.
2. Do not stretch, twist, puncture, or tear joint-sealant backer materials.
3. Remove absorbent joint-sealant backer materials that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants immediately following backer material installation, using proven techniques that comply with the following:

1. Place joint sealants so they fully contact joint substrates.
2. Completely fill recesses in each joint configuration.

3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants in accordance with the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING AND PROTECTION

A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.5 PAVING-JOINT-SEALANT SCHEDULE

A. Joints within concrete paving:

1. Joint Location:

a. Expansion and isolation joints in concrete paving.
b. Contraction joints in concrete paving.
c. Other joints as indicated.

2. Joint Sealant: Single-component, nonsag, silicone joint sealant.
3. Joint-Sealant Color: Manufacturer's standard

B. Joints within concrete paving and between concrete and asphalt paving

1. Joint Location:

a. Joints between concrete and asphalt paving.
b. Joints between concrete curbs and asphalt paving.
c. Other joints as indicated.

2. Joint Sealant: Hot-applied, single-component joint sealant

3. Joint-Sealant Color: Manufacturer's standard.

C. Fuel-resistant joints within concrete paving

1. Joint Location:

   a. Expansion and isolation joints in concrete paving.
   b. Contraction joints in concrete paving.
   c. Other joints as indicated.

2. Joint Sealant: Fuel-resistant, single-component, pourable, modified-urethane, elastomeric joint sealant
3. Joint-Sealant Color: Manufacturer's standard

END OF SECTION 321373

SECTION 321713 - PARKING BUMPERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Precast concrete wheel stops.

PART 2 - PRODUCTS

2.1 PARKING BUMPERS

A. Precast Concrete Wheel Stops: Precast, steel-reinforced, air-entrained concrete; 4000-psi minimum compressive strength; manufacturer's standard height and width long. Provide chamfered corners, and a minimum of two factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.

1. Source Limitations: Obtain wheel stops from single source from single manufacturer.
2. Surface Appearance: Smooth, free of pockets, sand streaks, honeycombs, and other obvious defects. Corners shall be uniform, straight, and sharp.
3. Mounting Hardware: Galvanized-steel spike or dowel, 1/2-inch diameter, 14-inch minimum length
4. Revise "Resilient Wheel Stops" Paragraph below to suit Project. Available products vary with manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is in suitable condition to begin installation in accordance with manufacturer's written instructions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

321713 - 1

3.2 INSTALLATION

A. Install wheel stops in accordance with manufacturer's written instructions unless otherwise indicated.

B. Securely anchor wheel stops to substrate with hardware in each preformed vertical hole in wheel stop as recommended in writing by manufacturer. Recess head of hardware beneath top of wheel stop.

END OF SECTION 321713

321713 - 2

SECTION 321723 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Painted markings applied to asphalt paving.
2. Painted markings applied to concrete surfaces.

1.3 ACTION SUBMITTALS

A. Product Data: Include technical data and tested physical and performance properties.

1. Pavement-marking paint, alkyd.
2. Glass beads.

B. Shop Drawings:

1. Indicate pavement markings, colors, lane separations, defined parking spaces, and dimensions to adjacent work.
2. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the ODOT Construction and Material Specifications for pavement-marking work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F (4.4 deg C) for alkyd materials, and not exceeding 95 deg F (35 deg C).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain pavement-marking paints from ODOT approved suppliers.

2.2 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" andICC A117.1>.

2.3 PAVEMENT-MARKING PAINT

A. Pavement-Marking Paint, Alkyd: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, colors complying with FS TT-P-1952F.

1. Color: White.

B. Pavement-Marking Paint: MPI #32 Alkyd Traffic Marking paint
1. Color: white

C. Glass Beads: AASHTO M 247, Type 1 or FS TT-B-1325D, Type 1

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement-marking substrate is dry and in suitable condition to begin pavement marking in accordance with manufacturer's written instructions.

B. Proceed with pavement marking only after unsatisfactory conditions have been corrected.

3.2 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow asphalt paving or concrete surfaces to age for a minimum of 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to asphalt paving or concrete surface. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil..
2. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal. (0.72 kg/L).

3.3 PROTECTING AND CLEANING

A. Protect pavement markings from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 321723

SECTION 321726 - TACTILE WARNING SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cast-in-place detectable warning tiles.

B. Related Requirements:

1. Section 321313 "Concrete Paving" for concrete walkways serving as substrates for tactile warning surfacing.
2. Section 321400 "Unit Paving" for unit paving installations incorporating detectable warning unit pavers specified in this Section.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For tactile warning surfacing, to include in maintenance manuals.

1.5 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Adhesive Application:

1. Apply adhesive only when ambient temperature is above 50 deg F and when temperature has not been below 35 deg F for 12 hours immediately before application. Do not apply when substrate is wet or contains excess moisture.

C. Weather Limitations for Mortar and Grout:

1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Provide artificial shade and windbreaks, and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F higher.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of tactile warning surfaces that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering and wear.
b. Separation or delamination of materials and components.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TACTILE WARNING SURFACING, GENERAL

A. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for tactile warning surfaces.

1. For tactile warning surfaces composed of multiple units, provide units that when installed provide consistent side-to-side and end-to-end dome spacing that complies with requirements.

B. Source Limitations: Obtain each type of tactile warning surfacing from and ODOT approved manufacture

2.2 DETECTABLE WARNING TILES

A. Cast-in-Place Detectable Warning Tiles: Accessible truncated-dome detectable warning tiles with replaceable surface configured for setting flush in new concrete walkway surfaces, with slip-resistant surface treatment on domes and field of tile.

1. Material: Cast-fiber-reinforced polymer concrete tile
2. Color: Safety yellow or Red brick
3. Shapes and Sizes:

a. Rectangular panel, 24 by 60 inches

4. Dome Spacing and Configuration: 1.67-inch to 2.35-inch in square pattern.

5. Mounting:

   a. Permanently embedded detectable warning tile wet-set into freshly poured concrete.
   b. Detectable warning tile set into formed recess in concrete and adhered with mortar
   c. Replaceable detectable warning tile wet-set into freshly poured concrete and surface-fastened to permanently embedded anchors.

2.3 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of tactile warning surfaces, noncorrosive and compatible with each material joined, and complying with the following:

   1. Furnish Type 316 stainless-steel fasteners for exterior use.
   2. Fastener Heads: For nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant heads, colored to match tile.

B. Adhesive: As recommended by manufacturer for adhering tactile warning surfacing unit to pavement.

C. Sealant: As recommended by manufacturer for sealing perimeter of tactile warning surfacing unit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is in suitable condition to begin installation according to manufacturer's written instructions. Verify that installation of tactile warning surfacing will comply with accessibility requirements upon completion.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF TACTILE WARNING SURFACING

A. General: Prepare substrate and install tactile warning surfacing according to manufacturer's written instructions unless otherwise indicated.

B. Place tactile warning surfacing units in dimensions and orientation indicated. Comply with location requirements of AASHTO MP 12.

3.3 INSTALLATION OF DETECTABLE WARNING TILES

A. Removable Cast-in-Place Detectable Warning Tiles:

1. Concrete Paving Installation: Comply with installation requirements in Section 321313 "Concrete Paving." Mix, place, and finish concrete to conditions complying with detectable warning tile manufacturer's written requirements for satisfactory embedment of removable tile.
2. Set each detectable warning tile accurately and firmly in place with embedding anchors and fasteners attached, and firmly seat tile back in wet concrete by tamping or vibrating. If necessary, temporarily apply weight to tiles to ensure full contact with concrete.
3. Set surface of tile flush with surrounding concrete and adjacent tiles, with variations between tiles and between concrete and tiles not exceeding plus or minus 1/8 inch (3 mm) from flush.
4. Protect exposed surfaces of installed tiles from contact with wet concrete. Complete finishing of concrete paving surrounding tiles. Remove concrete from tile surfaces.
5. Clean tiles using methods recommended in writing by manufacturer.

3.4 CLEANING AND PROTECTION

A. Remove and replace tactile warning surfacing that is broken or damaged or does not comply with requirements in this Section. Remove in complete sections from joint to joint unless otherwise approved by Architect. Replace using tactile warning surfacing installation methods acceptable to Architect.

B. Protect tactile warning surfacing from damage and maintain free of stains, discoloration, dirt, and other foreign material.

END OF SECTION 321726

SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Chain-link fences.
2. Swing gates.
3. Vertical pivot , motor-operated gates.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete equipment bases/pads for gate operators and controls and post footings.
2. Section 281500 "Access Control Hardware Devices" for gate controls.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Fence and gate posts, rails, and fittings.
b. Chain-link fabric, reinforcements, and attachments.
c. Gates and hardware.
d. Gate operators, including operating instructions and motor characteristics.

B. Shop Drawings: For each type of fence and gate assembly.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include accessories, hardware, gate operation, and operational clearances.
3. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
4. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer, testing agency, factory-authorized service representative.

B. Product Certificates: For each type of chain-link fence, operator, and gate.

C. Product Test Reports: For framework strength according to ASTM F1043, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gate operators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing fence grounding; member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Emergency Access Requirements: According to requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees and Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to comply with performance requirements.
b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
c. Faulty operation of gate operators and controls.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design chain-link fence and gate frameworks.

B. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to ASCE/SEI 7

1. Design Wind Load: 90mph.

a. Minimum Post Size: Determine according to ASTM F1043 for post spacing not to exceed 10 feet for Material Group IA, ASTM F1043, Schedule 40 steel pipe
b. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified.

C. Lightning Protection System: Maximum resistance-to-ground value of 25 ohms at each grounding location along fence under normal dry conditions.

D. Vertical Pivot Gate:
1. Width 24 feet, height 6 feet

2.2 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:

1. Fabric Height: As indicated on Drawings.
2. Steel Wire for Fabric: Wire diameter of 0.192 inch

a. Mesh Size: 2 inches
b. Aluminum-Coated Fabric: ASTM A491, Type I, 0.40 oz./sq. ft.
c. Zinc-Coated Fabric: ASTM A392, Type II, Class 1, 1.2 oz./sq. ft. with zinc coating applied before weaving.

3. Selvage: Knuckled at both selvages

2.3 FENCE FRAMEWORK

A. Posts and Rails ASTM F1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F1043 or ASTM F1083 based on the following:

1. Fence Height: As indicated on Drawings

2. Heavy-Industrial-Strength Material: Group IA, round steel pipe, Schedule 40

    a. Line Post: 1.9 inches in diameter
    b. End, Corner, and Pull Posts: 2.375 inches in diameter.

3. Horizontal Framework Members: Intermediate top and bottom rails according to ASTM F1043.

    a. Top Rail: 1.66 inches in diameter.

4. Brace Rails: ASTM F1043.
5. Metallic Coating for Steel Framework:

    a. Type A: Not less than minimum 2.0-oz./sq. ft. average zinc coating according to ASTM A123/A123M or 4.0-oz./sq. ft. zinc coating according to ASTM A653/A653M.
    b. Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.
    c. External, Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than 0.3-mil- thick, zinc-pigmented coating.
    d. Type C: Zn-5-Al-MM alloy, consisting of not less than 1.8-oz./sq. ft. coating.
    e. Coatings: Any coating above.

2.4 TENSION WIRE

A. Metallic-Coated Steel Wire: 0.177-inch- diameter, marcelled tension wire according to ASTM A817 or ASTM A824, with the following metallic coating:

1. Type I: Aluminum coated (aluminized).
2. Type II: Zinc coated (galvanized) by hot-dip process, with the following minimum coating weight:

    a. Class 3: Not less than 0.8 oz./sq. ft of uncoated wire surface.
    b. Class 4: Not less than 1.2 oz./sq. ft. of uncoated wire surface.
    c. Class 5: Not less than 2 oz./sq. ft. of uncoated wire surface.
    d. Matching chain-link fabric coating weight.

3. Type III: Zn-5-Al-MM alloy with the following minimum coating weight:

    a. Class 60: Not less than 0.6 oz./sq. ft. of uncoated wire surface.
    b. Class 100: Not less than 1 oz./sq. ft. of uncoated wire surface.
    c. Matching chain-link fabric coating weight.

2.5 SWING GATES

A. General: ASTM F900 for gate posts and single and double swing gate types

1. Gate Leaf Width: As indicated
2. Framework Member Sizes and Strength: Based on gate fabric height as indicated

B. Pipe and Tubing:

1. Zinc-Coated Steel: ASTM F1043 and ASTM F1083; protective coating and finish to match fence framework
2. Aluminum: ASTM B429/B429M; mill finish.
3. Gate Posts: Round tubular steel
4. Gate Frames and Bracing: Round tubular steel

C. Frame Corner Construction: Welded or assembled with corner fittings..

D. Hardware:

1. Hinges: 180-degree inward swing..
2. Latch: Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
3. Padlock

2.6 VERTICAL PIVOT GATES

A. Acceptable Manufacture
1. AutoGate, Inc Berlin Hights, Ohio – Model VPG-24 Vertical Pivot Gate System
   a. Cain link 300 – mesh and diagonal bracing
2. Request for substitutions will be considered in accordance with the provisions of the contract and bid conditions section 013100 of division 1

B. Gate Construction
1. Materials:
   a. Aluminum Assembly Framing:
      1) Plate, Shapes and Bar; ASTM B221, alloy 6061-t6 or 6063-t6
      2) Alloy and temper 6063-t6 except formed elbows shall be 6063-t4
      3) Round Aluminum Pipe: standard weight extruded structural aluminum pipe, allow 6063-t6 , mill finish, complying with ASTM b429
      4) Chain link style: 2-3/8”, sch 40 & sch 20 steel tubing/9 ga. Galv. Fabric over 22’ up to 24’
   b. Steel Assembly Framing:
      1) Chain link style: 2-3/8”, sch 40 & sch 20 steel tubing/9 ga. Galv. Fabric over 12’ up to 22’
      2) Steel Tubes: ASTM a500 cold formed welded pipe and structural tubing hot-dipped, zick-coated
      3) Steel shapes plates and bars: ASTM A36
   c. Threaded Fasteners;
      1) All exterior screws, olts, nut and washer shall be 300 series non-magnetic stainless steel.

2) Provide lock washers or other locking devices such as deformed thread lock or nylon locking nuts at all bolted connections

d. Infill Panels: refer to line fence

e. Fabrication:

1) Fabricate frames or gates from aluminum tubing. Assemble gate frames by welding at corners. Infill grate frames with panels to match adjacent fence panels.

2) Configuration: size and space members in compliance with applicable codes and project specifications:

a) Fully assemble gate leaves in the manufacture's shop with no joints spliced or bolted sections. Open tube ends or sections are not acceptable.

b) Welded to make exposed joint butt tight, flush, and hairline. Continuously seal joined members by continuous welds.

c) Fabricated frame and infill fabrics: gate frame can be painted to match epoxy coated or pvc coated fabrics, or unpainted mill finish to match a galvanized fabric.

d) Provide components required for receiving yoke anchorage or gate ends. Fabricate anchors and related components of material and finish matching gate frame.

3) Wind Bracing:

a) Provide diagonal welded pipe gate trusses to prevent sag.

b) Cable Wind Bracing: required for gates over 16' or more in length and up to 20' in length. Provide 3/16" aircraft coated cable anchored to the operator and at 2/3 the length of the gate.

c) Masted Wind Bracing: required for gates over 20' or more in length or more than 7' in height, and/or code requirement beyond 75mph winds. Provide continuous tube elements which attach to the operator and extend a minimum of 2/3 the length of the gate. Wind bracing is also secured to the bottom of the gate with strut plates.

2.7 FITTINGS

A. Provide fittings according to ASTM F626..

B. Post Caps: Provide for each post.

1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top Rail Sleeves: Pressed-steel or round-steel tubingnot less than 6 inches long.
2. Rail Clamps: Line and corner boulevard clamps for connecting bottom rails to posts.

E. Tension and Brace Bands: Pressed steel.

F. Tension Bars: Steel or Aluminum, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

H. Tie Wires, Clips, and Fasteners: According to ASTM F626.

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:

a. Hot-Dip Galvanized Steel: 0.106-inch- diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.

I. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. of zinc.

a. Polymer coating over metallic coating.

2. Aluminum: Mill finish.

2.8 GATE OPERATORS

A. Operators: Factory-assembled, automatic, gate-operating system designed for gate size, type, weight, and frequency of use. Control system shall have characteristics suitable for Project conditions, with control stations, safety devices, and weatherproof enclosures.

1. Operator design shall allow for removal of cover or motor without disturbing limit-switch adjustment and without affecting auxiliary emergency operation.
2. Electronic components shall have built-in troubleshooting diagnostic feature.
3. Unit shall be designed and wired for both right-hand/left-hand opening, permitting universal installation.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. UL Standard: Manufacture and label gate operators according to UL 325.

D. Motors: Comply with NEMA MG 1.

1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
3. Service Factor: 1.15.

.

4. Electrical Characteristics:

    a. Horsepower: as indicated
    b. Voltage: NEMA Standard voltage selected to operate on nominal circuit voltage to which motor is connected.

E. Gate Operators: Equipment base/pad mounted and as follows:

1. Mechanical Pivot Gate Operators:

    a. Duty: Heavy duty, commercial/industrial.
    b. Gate Speed: Fully open to fully closed and fully closed to fully open not less than 10-12 second.
    c. Maximum Gate Weight: As indicated
    d. Frequency of Use: Continuous duty
    e. Mechanical Gate Operator Drive: 24 VDC high torque gear motor and DBL reduction DBL "V" belt design

F. Gate Operator Enclosure: fabricated operator enclosure from steel tubing and sheet metal. Continuous seal weld all frames seams with welds ground smooth. Screwed frames are not acceptable.
1. Frame: 2" sq. 11 ga. (0.120) Steel Tubing
2. Skins: 18 ga. Galvanized Sheet
3. Mounting Pads: 3" wide x 3/8" thick 304 stainless steel
4. Finish: Operator Skins powder coated black

G. Control Devices: Electric controls separated from gate and motor and drive mechanism with NEMA ICS 6, type 1 enclosure for pedestal mounting and with space for additional optional equipment. Provide the following remote control devices.

1. Card Reader: Functions only when authorized card is presented. Programmable, magnetic multiple code system

    a. Reader Type: Swipe or Proximity
    b. Features: Capable of monitoring and auditing gate activity

2. Radio Control: Digital system consisting of code-compatible universal receiver for each gate, located where indicated, with remote antenna with coaxial cable and mounting brackets designed to operate gates. Provide two programmable transmitter(s) with multiple-code capability, permitting validating or voiding of not less than 10,000 codes per channel configured for the following functions:

    a. Transmitters: Three-button operated, with open and close function.
    b. Channel Settings: Four independent channel settings controlling separate receivers for operating more than one gate from each transmitter.

3. Vehicle Presence Detector: System that includes automatic closing timer with adjustable time delay before closing, timer cut-off switch, and presence detector designed to hold gate open until traffic clears

a. Provide emitter/receiver detector with adjustable detection zone pattern and sensitivity, designed to detect the presence or transit of a vehicle in gate pathway when infrared beam in zone pattern is interrupted, and to emit a signal activating the gate operator.

H. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:

1. Action: Hold Open until clear of obstruction.
2. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
3. Sensor Edge: Contact-pressure-sensitive safety edge, profile, and sensitivity designed for type of gate and component indicated, in locations as follows. Connect to control circuit using gate edge transmitter and operator receiver system

   a. Along entire gate leaf leading edge.
   b. Across entire gate leaf bottom edge.
   c. Where indicated on the drawings

4. Photoelectric/Infrared Sensor: Designed to detect an obstruction in gate's path when infrared beam in the zone pattern is interrupted.

I. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop gate at fully open and fully closed positions.

J. Emergency Release Mechanism: Quick-disconnect release of operator drive system, permitting manual operation if operator fails. Control circuit power is disconnected during manual operation.

1. Type: Integral fail-safe release, allowing gate to be lifted open without mechanical devices, keys, cranks, or special knowledge

K. Operating Features:

1. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features with capability for monitoring and auditing gate activity. Provide unit that is isolated from voltage spikes and surges.
2. System Integration: With controlling circuit board capable of accepting any type of input from external devices.
3. Master/Slave Capability: Control stations designed and wired for gate pair operation.
4. Automatic Closing Timer: With adjustable time delay before closing
5. Open Override Circuit: Designed to override closing commands.
6. Reversal Time Delay: Designed to protect gate system from shock load on reversal in both directions.
7. Maximum Run Timer: Designed to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.
8. Clock Timer: 24 hour, programmable for regular events.

L. Accessories:

1. Warning Module: Audio and Visual strobe-light alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving.

2. Battery Backup System: Battery-powered drive and access-control system, independent of primary drive system.

    a. Fail Safe: Gate opens and remains open until power is restored.
    b. Fail Secure: Gate cycles on battery power, then fail safe when battery is discharged.

3. External electric-powered solenoid lock with delay timer allowing time for lock to release before gate operates.
4. Fire box.
5. Fire strobe alarm.
6. Intercom System:
7. Instructional, Safety, and Warning Labels and Signs: Manufacturer's standard for components and features specified
8. Equipment Bases/Pads: Cast-in-place or precast concrete, 6 to 12 inches below frost line or detail on Drawings, dimensioned and reinforced according to gate-operator component manufacturer's written instructions and as indicated on Drawings.

2.9 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

2.10 GROUNDING MATERIALS

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connectors and Grounding Rods: Listed and labeled for complying with UL 467.

1. Connectors for Below-Grade Use: Exothermic welded type.
2. Grounding Rods: Copper-clad steel, 5/8 by 96 inches

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for a certified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 CHAIN-LINK FENCE INSTALLATION

A. Install chain-link fencing according to ASTM F567 and more stringent requirements specified.

1. Install fencing on established boundary lines inside property line.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
   a. Concealed Concrete: Place top of concrete 2 inches below to allow covering with surface material.

D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more. For runs exceeding 500 feet, space pull posts an equal distance between corner or end posts.

E. Line Posts: Space line posts uniformly at 96 inches o.c.

F. Post Bracing and Intermediate Rails: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric 72 inches or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

G. Tension Wire: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:

1. Extended along top and bottom of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.

H. Top Rail: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

I. Intermediate and Bottom Rails: Secure to posts with fittings.

J. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 1-inch bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

K. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than 15 inches o.c.

L. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric according to ASTM F626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches (o.c.

M. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side

3.4 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.5 GATE-OPERATOR INSTALLATION

A. Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.

B. Excavation: Hand-excavate holes for posts, pedestals, and equipment bases/pads, in firm, undisturbed soil to dimensions and depths and at locations according to gate-operator component manufacturer's written instructions and as indicated.

C. Ground electric-powered motors, controls, and other devices according to NFPA 70 and manufacturer's written instructions.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests.

B. Grounding Tests: Comply with requirements in Section 264113 "Lightning Protection for Structures."

C. Prepare test reports.

3.7 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding..

B. Automatic Gate Operator: Energize circuits to electrical equipment and devices, start units, and verify proper motor rotation and unit operation.

1. Hydraulic Operator: Purge operating system, adjust pressure and fluid levels, and check for leaks.
2. Test and adjust operators, controls, alarms, and safety devices. Replace damaged and malfunctioning controls and equipment.
3. Lubricate operator and related components.

C. Lubricate hardware and other moving parts.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION 323113

SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS.

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Seeding.
2. Sodding.
3. Erosion-control materials.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation and drawing designations for planting soils.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.

1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
2. Experience: Five years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the National Association of Landscape Professionals:

    a. Landscape Industry Certified Technician - Exterior.
    b. Landscape Industry Certified Lawn Care Manager.
    c. Landscape Industry Certified Lawn Care Technician.

5. Pesticide Applicator: State licensed, commercial.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

C. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

1.8 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species:

1. Quality, State Certified: State-certified seed of grass species as listed below for solar exposure.

2.2 TURFGRASS SOD

A. Turfgrass Sod: Certified and Approved, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.

2.3 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition:
   a. Per ODOT construction and materials specifications

2.4 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.5 EROSION-CONTROL MATERIALS

.

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd. with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

C. Erosion-Control Mats: Cellular, nonbiodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of 3-inch nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
   1. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation”

B. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Turf Area Preparation" Article..

B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.

C. Fill cells of erosion-control mat with planting soil and compact before planting..

D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.

   1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

2. Do not use wet seed or seed that is moldy or otherwise damaged.
3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.

C. Protect seeded areas with erosion-control mats where indicated on Drawings; install and anchor according to manufacturer's written instructions.

D. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
2. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft.. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

3.6 SODDING

A. Lay sod within 24 hours of harvesting Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across slopes exceeding 1:3.
2. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than two anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.7 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.

2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet.

D. Turf Postfertilization: Apply commercial fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.8 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches
2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
3. Satisfactory Plugged Turf: At end of maintenance period, the required number of plugs has been established as well-rooted, viable patches of grass, and areas between plugs are free of weeds and other undesirable vegetation.
4. Satisfactory Sprigged Turf: At end of maintenance period, the required number of sprigs has been established as well-rooted, viable plants, and areas between sprigs are free of weeds and other undesirable vegetation.

B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.9 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations.

Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.10 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove nondegradable erosion-control measures after grass establishment period.

ND OF SECTION 329200

SECTION 330500 - COMMON WORK RESULTS FOR UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Piping joining materials.
2. Transition fittings.
3. Sleeves.
4. Identification devices.
5. Grout.
6. Flowable fill.
7. Piped utility demolition.
8. Piping system common requirements.
9. Equipment installation common requirements.
10. Painting.
11. Concrete bases.
12. Metal supports and anchorages.

1.3 DEFINITIONS

.

A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.

B. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

C. CPVC: Chlorinated polyvinyl chloride plastic.

D. PVC: Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Identification devices.

1.5 QUALITY ASSURANCE

A. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

B. Coordinate installation of identifying devices after completing covering and painting if devices are applied to surfaces.

C. Coordinate size and location of concrete bases. Formwork, reinforcement, and concrete requirements are specified in Section 033000 "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.1 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness, unless otherwise indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

E. Solvent Cements for Joining Plastic Piping:
   1. CPVC Piping: ASTM F493.
   2. PVC Piping: ASTM D2564. Include primer according to ASTM F656.
   3. PVC to ABS Piping Transition: ASTM D3138.

2.2 TRANSITION FITTINGS

A. Transition Fittings, General: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

B. Transition Couplings NPS 1-1/2 (DN 40) and Smaller:

   1. Underground Piping: Manufactured piping coupling or specified piping system fitting.
   2. Aboveground Piping: Specified piping system fitting.

C. AWWA Transition Couplings NPS 2 (DN 50) and Larger:
   1. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.

D. Plastic-to-Metal Transition Fittings:
   1. Description CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

E. Plastic-to-Metal Transition Unions:
   1. Description: MSS SP-107, CPVC and PVC four-part union. Include brass or stainless-steel threaded end, solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.

F. Flexible Transition Couplings for Underground Nonpressure Drainage Piping:
   1. Description: ASTM C1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.3 SLEEVES

A. Mechanical sleeve seals for pipe penetrations are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

B. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

C. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, galvanized, plain ends.

D. Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

E. Molded PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe Sleeves: ASTM D1785, Schedule 40.

G. Molded PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.4 IDENTIFICATION DEVICES

A. General: Products specified are for applications referenced in other utilities Sections. If more than single type is specified for listed applications, selection is Installer's option.

B. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.

1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
2. Location: Accessible and visible.

C. Stencils: Standard stencils prepared with letter sizes complying with recommendations in ASME A13.1. Minimum letter height is 1-1/4 inches for ducts, and 3/4 inch for access door signs and similar operational instructions.

1. Material: Brass
2. Stencil Paint: Exterior, oil-based, alkyd-gloss black enamel, unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, oil-based, alkyd enamel in colors according to ASME A13.1, unless otherwise indicated.

D. Snap-on Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap-on type. Include color-coding according to ASME A13.1, unless otherwise indicated.

E. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe at each location.

F. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers, at least three times letter height and of length required for label.

G. Lettering: Manufacturer's standard preprinted captions as selected by Architect.

H. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.

1. Arrows: Either integrally with piping system service lettering to accommodate both directions of flow, or as separate unit on each pipe marker to indicate direction of flow.

I. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least 3 mils thick.

1. Width: 1-1/2 inches on pipes with OD, including insulation, less than 6 inches; 2-1/2 inches for larger pipes.
2. Color: Comply with ASME A13.1, unless otherwise indicated.

J. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Include 5/32-inch hole for fastener.
   1. Material: Valve manufacturer's standard solid plastic.
   2. Size: 1-1/2 inches in diameter, unless otherwise indicated.
   3. Shape: As indicated for each piping system.

K. Valve Tag Fasteners: Brass, wire-link or beaded chain; or brass S-hooks.

L. Engraved Plastic-Laminate Signs: ASTM D709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

   1. Engraving: Engraver's standard letter style, of sizes and with terms to match equipment identification.
   2. Thickness: 1/16 inch, for units up to 20 sq. in. or 8 inches) in length, and 1/8 inch for larger units.
   3. Fasteners: Self-tapping, stainless-steel screws or contact-type permanent adhesive.

M. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in the following color codes:

   1. Green: Cooling equipment and components.
   2. Yellow: Heating equipment and components.
   3. Brown: Energy reclamation equipment and components.
   4. Blue: Equipment and components that do not meet criteria above.
   5. Hazardous Equipment: Use colors and designs recommended by ASME A13.1.
   6. Terminology: Match schedules as closely as possible. Include the following:

      a. Name and plan number.
      b. Equipment service.
      c. Design capacity.
      d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

   7. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

N. Plasticized Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with mat finish suitable for writing.

   1. Size: 3-1/4 by 5-5/8 inches.
   2. Fasteners: Brass grommets and wire.
   3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.

O. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in piped utility identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of piped utility systems and equipment.

1. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

2.5 GROUT

A. Description: ASTM C1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.6 FLOWABLE FILL

A. Description: Low-strength-concrete, flowable-slurry mix.

1. Cement: ASTM C150, Type I, portland.
2. Density: 115- to 145-lb/cu. ft.
3. Aggregates: ASTM C33, natural sand, fine and crushed gravel or stone, coarse.
4. Water: Comply with ASTM C94/C94M.
5. Strength: 100 to 200 psig at 28 days.

PART 3 - EXECUTION

3.1 PIPED UTILITY DEMOLITION

A. Refer to Section 024119 "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping. Fill abandoned piping with flowable fill, and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING INSTALLATION

A. Install piping according to the following requirements and utilities Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping to permit valve servicing.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Sleeves are not required for core-drilled holes.

J. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of equipment areas or other wet areas 2 inches above finished floor level.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

a. PVC Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.

K. Verify final equipment locations for roughing-in.

L. Refer to equipment specifications in other Sections for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and utilities Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

E. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

F. Soldered Joints: Apply ASTM B813 water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B32.

G. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.

H. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D2235 and ASTM D2661 appendixes.
3. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
5. PVC Nonpressure Piping: Join according to ASTM D2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D3138 Appendix.

I. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D3212.

J. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Install dielectric fittings at connections of dissimilar metal pipes.

3.5 EQUIPMENT INSTALLATION

A. Install equipment level and plumb, unless otherwise indicated.

B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.

C. Install equipment to allow right of way to piping systems installed at required slope.

3.6 PAINTING

A. Painting of piped utility systems, equipment, and components is specified in Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 IDENTIFICATION

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.

1. Stenciled Markers: According to ASME A13.1.
2. Locate pipe markers on exposed piping according to the following:

    a. Near each valve and control device.
    b. Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.
    c. Near locations where pipes pass through walls or floors or enter inaccessible enclosures.
    d. At manholes and similar access points that permit view of concealed piping.
    e. Near major equipment items and other points of origination and termination.

B. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.

1. Lettering Size: Minimum 1/4 inch high for name of unit if viewing distance is less than 24 inches, 1/2 inch high for distances up to 72 inches, and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
2. Text of Signs: Provide name of identified unit. Include text to distinguish among multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

C. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

3.8 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Section 055000 "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor piped utility materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.10 GROUTING

A. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 330500

SECTION 331415 - SITE WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water-distribution piping and related components outside the building.

B. Related Requirements:.

1. Section 031000 "Concrete Forming and Accessories."
2. Section 032000 "Concrete Reinforcing."
3. Section 211000 "Water-Based Fire-Suppression Systems."
4. Section 315000 "Excavation Support and Protection."

1.2 DEFINITIONS

A. CDA: Copper Development Association.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. PA: Polyamide (nylon) plastic.

D. PE: Polyethylene plastic.

E. PP: Polypropylene plastic.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Submittals:

1. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare piping, valves, meters, backflow prevention devices, and fire hydrants according to the following:

1. Ensure that piping, valves, meters, backflow prevention devices, and fire hydrants are dry and internally protected against rust and corrosion.
2. Protect threaded ends and flange faces against damage.
3. Set piping, valves, meters, backflow prevention devices, and fire hydrants in best position for handling and to prevent rattling.

B. During Storage: Use precautions for piping, valves, meters, backflow prevention devices, and fire hydrants according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle products if size requires handling by crane or lift. Rig products to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service in accordance with requirements indicated:

1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of water-distribution service without Construction Manager's and Owner's written permission.

1.8 COORDINATION

A. Coordinate connection to water main with utility company.

B. Content includes water-distribution piping and related components outside the building for domestic water service, fire-suppression water service, and terminated 5 ft. from building. Terminate water-service piping with appropriate fitting for extension by 21 and 22.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.

B. Comply with standards of authorities having jurisdiction for domestic water-service piping, including materials, installation, testing, and disinfection.

C. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

D. Piping materials to bear label, stamp, or other markings of specified testing agency.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

F. Comply with ASTM F645 for selection, design, and installation of thermoplastic water piping.

G. Comply with FM Approvals' "Approval Guide" and/or UL's "Fire Protection Equipment Directory" for fire-suppression water-service products.

H. Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-suppression water-service piping.

I. All piping and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61/NSF 372 or are certified in compliance with NSF 61/NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PIPING MATERIALS

A. Comply with requirements in "Piping Applications" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and service sizes.

B. Potable-water piping and components comply with NSF 14, NSF 61, and NSF 372.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. AWWA C104/A21.4 cement mortar-lined.

B. Mechanical-Joint, Ductile-Iron Fittings:

1. AWWA C110, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
3. AWWA C104/A21.4 cement mortar-lined.

C. Push-on-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. AWWA C104/A21.4 cement mortar-lined.

D. Push-on-Joint, Ductile-Iron Fittings:

1. AWWA C110, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
2. Gaskets: AWWA C111/A21.11, rubber.
3. AWWA C104/A21.4 cement mortar-lined.

E. Grooved-End, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with cut, rounded-grooved ends.
2. AWWA C104/A21.4 cement mortar-lined.

F. Grooved-End, Ductile-Iron Pipe Appurtenances:
1. Source Limitations: Obtain grooved-end, ductile-iron pipe appurtenances from single manufacturer.
2. Grooved-End, Ductile-Iron Fittings:

a. ASTM A536, ductile-iron castings with dimensions matching pipe.
b. AWWA C104/A21.4 cement mortar-lined.

3. Grooved-End, Ductile-Iron-Piping Mechanical Couplings:

a. AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

G. Flanges: ASME 16.1, Class 125, cast iron.

2.4 PE PIPE AND FITTINGS

A. PE, ASTM Pipe: ASTM D2239, SIDR No. 5.3, 7, or 9; with PE compound number required to give pressure rating not less than 200 psig

1. Insert Fittings for PE Pipe: ASTM D2609, made of PA, PP, or PVC with serrated male insert ends matching inside of pipe. Include bands or crimp rings.
2. Molded PE Fittings: ASTM D3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

B. PE, AWWA Pipe: AWWA C906, DR No. 7.3, 9, or 9.3; with PE compound number required to give pressure rating not less than 200 psig

1. PE, AWWA Fittings: AWWA C906, socket- or butt-fusion type, with DR number matching pipe and PE compound number required to give pressure rating not less than 200 psig .

C. PE, Fire-Service Pipe: ASTM F714, AWWA C906, or equivalent for PE water pipe; FM Global approved, with minimum thickness equivalent to FM Global Class 150 and Class 200.

1. Molded PE Fittings: ASTM D3350, PE resin, socket- or butt-fusion type, and made to match PE pipe dimensions and class.

2.5 PVC PIPE AND FITTINGS

A. PVC, Schedule 40 Pipe: ASTM D1785.

1. PVC, Schedule 40 Socket Fittings: ASTM D2466.

B. PVC, Schedule 80 Pipe: ASTM D1785.

1. PVC, Schedule 80 Socket Fittings: ASTM D2467.
2. PVC, Schedule 80 Threaded Fittings: ASTM D2464.

C. PVC Pipe: **AWWA C900** with bell end with gasket, and with spigot end.

1. Comply with UL 1285 for fire-suppression water service.
2. PVC Fabricated Fittings: AWWA C900,with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
3. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.

2.6 SPECIAL PIPE FITTINGS

A. Ductile-Iron Rigid Expansion Joints: Three-piece, ductile-iron assembly consisting of telescoping sleeve with gaskets and restrained-type, ductile-iron, end sections.
1. Source Limitations: Obtain ductile-iron rigid expansion joints from single manufacturer.
2. Standards: AWWA C110 or AWWA C153/A21.53; AWWA C111/A21.11.
3. Pressure Rating: 250 psig minimum.

B. Ductile-Iron Flexible Expansion Joints: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends. Include two gasketed ball-joint sections and one or more gasketed sleeve sections.

1. Source Limitations: Obtain ductile-iron flexible expansion joints from single manufacturer.
2. Standards: AWWA C110 or AWWA C153/A21.53; AWWA C111/A21.11.
3. Pressure Rating: 250 psig minimum.

C. Ductile-Iron Deflection Fittings: Compound, ductile-iron coupling fitting with sleeve and one or two flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends.
1. Source Limitations: Obtain ductile-iron deflection fittings from single manufacturer.
2. Standards: AWWA C110 or AWWA C153/A21.53; AWWA C111/A21.11.
3. Pressure Rating: 250 psig minimum.

2.7 PIPING JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series.

B. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

C. Gaskets for Ferrous Piping and Copper-Alloy Tubing: ASME B16.21, asbestos free.

D. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.8 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Tubular-Sleeve Pipe Couplings: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.
1. Source Limitations: Obtain tubular-sleeve pipe couplings from single manufacturer.
2. Standard: AWWA C219.
3. Center-Sleeve Material: Manufacturer's standard
4. Gasket Material: Natural or synthetic rubber.
5. Pressure Rating: 200 psig minimum.
6. Metal Component Finish: Corrosion-resistant coating or material.

C. Split-Sleeve Pipe Couplings: Metal, bolted, split-sleeve-type, reducing or transition coupling with sealing pad and closure plates, O-ring gaskets, and bolt fasteners.
1. Source Limitations: Obtain split-sleeve pipe couplings from single manufacturer.
2. Standard: AWWA C227.
3. Sleeve Material: Manufacturer's standard
4. Sleeve Dimensions: Of thickness and width required to provide pressure rating.
5. Gasket Material: O-rings made of EPDM rubber unless otherwise indicated.
6. Pressure Rating: 200 psig minimum.
7. Metal Component Finish: Corrosion-resistant coating or material.

D. Flexible Connectors:

1. Nonferrous-Metal Piping: Bronze hose covered with bronze wire braid; with copper-tube, pressure-type, solder-joint ends or bronze flanged ends brazed to hose.
2. Ferrous-Metal Piping: Stainless steel hose covered with stainless steel wire braid; with ASME B1.20.1, threaded steel pipe nipples or ASME B16.5, steel pipe flanges welded to hose.

E. Dielectric Fittings: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

1. Dielectric Unions:

   a. Standard: ASSE 1079.
   b. Pressure Rating: 250 psig
   c. End Connections: Solder-joint copper alloy and threaded ferrous.

2. Dielectric Flanges:

   a. Standard: ASSE 1079.
   b. Pressure Rating: 125 psig minimum at 180 deg F
   c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

3. Dielectric-Flange Insulating Kits: Nonconducting materials for field assembly of companion flanges.

   a. Pressure Rating: 150 psig
   b. Gasket: Neoprene or phenolic.
   c. Bolt Sleeves: Phenolic or PE.
   d. Washers: Phenolic with steel backing washers.

4. Dielectric Nipples:

   a. Standard: IAPMO PS 66.
   b. Electroplated steel nipple complying with ASTM F1545.
   c. Pressure Rating: 300 psig at 225 deg F
   d. End Connections: Male threaded or grooved.
   e. Lining: Inert and noncorrosive, PP.

2.9 ENCASEMENT FOR PIPING

A. Standards: ASTM A674 or AWWA C105/A21.5.

B. Form: Sheet or tube.

C. Material: Linear low-density PE film of 0.008-inch minimum thickness or high-density, cross-laminated PE film of 0.004-inch minimum thickness

D. Color:Black or natural

2.10 CORPORATION VALVES, CURB VALVES, AND METER VALVES

A. Source Limitations: Obtain corporation valves, curb valves, and meter valves from single manufacturer.

B. Corporation Valves: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.

1. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
2. Corporation Valve: Bronze body, ground-key plug or ball, with AWWA C800, threaded inlet and outlet matching service piping material.
3. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.

C. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.

1. Service Boxes for Curb Valves: ASTM A48/A48M, Class 25 cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches in diameter.

a. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

D. Meter Valves: Comply with AWWA C800 for high-pressure, service-line valves. Include angle or straight-through-pattern bronze body, ground-key plug or ball, wide tee head, with inlet and outlet matching service piping material.

2.11 WATER METERS.

A. Water Meter - Utility Company Furnished:

1. Utility Company: City of Eaton

2.12 WATER METER BOXES

A. Water Meter Boxes:
1. Water Meter Boxes: Polymer-concrete body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping. Include vertical and lateral design loadings of 15,000 lb minimum over 10 by 10 inches square.

2.13 VALVE APPLICATIONS

A. Use corporation valves and curb valves with ends compatible with piping, for nps 2and smaller installation.

2.14 FIRE HYDRANTS

A. Fire Hydrants – per City of Eaton standards

2.15 FLUSHING HYDRANTS

A. Flushing Hydrants - Post Type: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.
   1. Source Limitations: Obtain flushing hydrants - post type, from single manufacturer.
   2. Pressure Rating: 150 psig minimum.
   3. Outlet: One, with horizontal discharge.
   4. Hose Thread: NPS 2-1/2 , with NFPA 1963 external hose thread for use by local fire department, and with cast-iron cap with brass chain.
   5. Barrel: Cast-iron or steel pipe with breakaway feature.
   6. Valve: Bronze body with bronze-ball or plunger closure, and automatic draining.
   7. Security: Locking device for padlock.
   8. Exterior Finish: Red alkyd-gloss enamel paint unless otherwise indicated.
   9. Inlet: NPS 2 minimum.
   10. Operating Wrench: One for each unit.

B. Flushing Hydrants - Ground Type: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.
   1. Source Limitations: Obtain flushing hydrants - ground type, from single manufacturer.
   2. Pressure Rating: 150 psig) minimum.
   3. Outlet: One, with vertical discharge.
   4. Hose Thread: NPS 2-1/2 with NFPA 1963 external hose thread for use by local fire department, and with cast-iron cap with brass chain.
   5. Barrel: Cast-iron or steel pipe.
   6. Valve: Bronze body with bronze-ball or plunger closure, and automatic draining.
   7. Inlet: NPS 2 minimum.
   8. Hydrant Box: Cast iron with cover, for ground mounting.
   9. Operating Wrench: One for each unit.

2.16 FIRE DEPARTMENT CONNECTIONS

A. Fire Department Connections:
   1. Source Limitations: Obtain fire department connections from single manufacturer.
   2. Standard: UL 405.
   3. Configuration: Freestanding, with cast-bronze body, thread inlets in accordance with NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- high, brass sleeve; and round escutcheon plate.

2.17 ALARM DEVICES

A. Alarm Devices: UL 753 and FM Global approved, of types and sizes to mate and match piping and equipment.

B. Water-Flow Indicators: Vane-type water-flow detector, rated for 250 psig working pressure; designed for horizontal or vertical installation; with 2 SPDT circuit switches to provide isolated alarm and auxiliary contacts, 7 A, 125 V ac and 0.25 A, 24 V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal when cover is removed.

C. Supervisory Switches: SPDT; designed to signal valve in other than fully open position.

D. Pressure Switches: SPDT; designed to signal increase in pressure.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with excavating, trenching, and backfilling requirements in Section 312000 "Earth Moving."

3.2 PIPING APPLICATIONS

A. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used unless otherwise indicated.

B. Do not use flanges or unions for underground piping.

C. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

D. Underground water-service piping NPS 3/4 to NPS 3 to be any of the following:
   1. PE, ASTM pipe; molded PE fittings; and heat-fusion joints.
   2. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented joints.

E. Underground water-service piping NPS 4 to NPS 8 to be any of the following:
   1. Ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.
   2. PE, AWWA pipe; PE, AWWA fittings; and heat-fusion joints.
   3. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented joints.
   4. NPS 4 and NPS 6: NPS 6 PVC, AWWA Class 150 pipe; PVC, AWWA Class 150 fabricated or molded fittings; and gasketed joints.
   5. NPS 8 (DN 200): PVC, AWWA Class 200 pipe; PVC, AWWA Class 200 fabricated push-on-joint, ductile-iron mechanical-joint, ductile-iron fittings; and gasketed joints.

F. Water Meter Box Water-Service Piping: NPS 3/4 to NPS 2 to be same as underground water-service piping.

G. Aboveground and vault water-service piping NPS 3/4 to NPS 3 to be any of the following:
   1. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented threaded fittings; and threaded joints.

H. Aboveground and vault water-service piping NPS 4 to NPS 8 to be any of the following:
   1. Ductile-iron, grooved-end pipe; ductile-iron, grooved-end appurtenances; and grooved joints.
   2. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented threaded fittings; and threaded joints.
   3. .

I. Underground fire-service-main piping NPS 4 to NPS 12 to be any of the following:

   1. Ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanicaljoints.
   2. PVC, AWWA Class 150 pipe listed for fire-protection service; PVC Class 150 fabricated or molded fittings; and gasketed joints.
   3. PVC, AWWA Class 200 pipe listed for fire-protection service; PVC Class 200 fabricated fittings; and gasketed joints.

J. Aboveground and vault fire-service-main piping NPS 4 to NPS 12 to be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.

K. Underground Combined Water-Service and Fire-Service-Main Piping NPS 6 to NPS 12 to be any of the following:

   1. Ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.
   2. PVC, AWWA Class 200 pipe listed for fire-protection service; PVC fabricated or molded fittings of same class as pipe; and gasketed joints.
   3. Fiberglass, AWWA, FM Global approved RTRP, Class 200; RTRF; and gasketed joints.

L. Aboveground and vault combined water service and fire-service-main piping NPS 6 to NPS 12 to be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.

3.3 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for NPS 3 (DN 80) and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FM Global, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 (DN 50) and smaller installation.

   1. Detector Check Valves: Use for water-service piping in vaults and aboveground to detect unauthorized use of water.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Comply with Section 330500 "Common Work Results for Utilities" for piping-system common requirements.

B. Provide a continuous bare copper or aluminum tracer wire not less than 0.10 inch in diameter in sufficient length over each separate run of nonmetallic pipe.

3.5 INSTALLATION OF PIPING

A. Water-Main Connection:

1. Arrange with utility company for tap of size and in location indicated in water main.
2. Tap water main in accordance with requirements of water utility company and of size and in location indicated.

B. Make connections larger than NPS 2 with tapping machine according to the following:

1. Install tapping sleeve and tapping valve in accordance with MSS SP-60.
2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box..

C. Make connections NPS 2 and smaller with drilling machine according to the following:

1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
4. Install corporation valves into service-saddle assemblies.
5. Install manifold for multiple taps in water main.
6. Install curb valve in water-service piping with head pointing up and with service box.

D. Comply with NFPA 24 for fire-service-main piping materials and installation.

1. Install PE corrosion-protection encasement in accordance with ASTM A674 or AWWA C105/A21.5.
2. Install copper tube and fittings in accordance with CDA's "Copper Tube Handbook."

E. Install ductile-iron, water-service piping in accordance with AWWA C600 and AWWA M41.

1. Install PE corrosion-protection encasement in accordance with ASTM A674 or AWWA C105/A21.5.

F. Install PE pipe in accordance with ASTM D2774 and ASTM F645.

G. Install PVC, AWWA pipe in accordance with ASTM F645 and AWWA M23.

H. Install fiberglass AWWA pipe in accordance with AWWA M45.

I. Bury piping with depth of cover over top at least b30 inches, with top at least 12 inches below level of maximum frost penetration, and according to the following:

1. Under Driveways: With at least 36 inches of cover over top.
2. Under Railroad Tracks: With at least 48 inches of cover over top.

3. In Loose Gravelly Soil and Rock: With at least 12 inches (of additional cover.

J. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.

K. Extend water-service and fire-suppression water-service piping and connect to water-supply source and building water-piping and fire-suppression piping systems at outside face of building wall in locations and pipe sizes indicated.

1. Terminate water-service and fire-suppression water-service piping at building wall until building water-piping and fire-suppression piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building water-piping and fire-suppression piping systems when those systems are installed.

L. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

M. Comply with Section 211000 "Water-Based Fire-Suppression Systems" for fire-suppression-water piping inside the building.

N. Comply with Section 221116 "Domestic Water Piping" for potable-water piping inside the building.

3.6 JOINT CONSTRUCTION

A. Comply with Section 330500 "Common Work Results for Utilities" for basic piping joint construction.

B. Make pipe joints according to the following:

1. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools and procedures recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
2. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
3. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
4. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts in accordance with coupling manufacturer's written instructions.
5. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners in accordance with fitting manufacturer's written instructions.
6. PVC Piping Gasketed Joints: Use joining materials in accordance with AWWA C900. Construct joints with elastomeric seals and lubricant in accordance with ASTM D2774 or ASTM D3139 and pipe manufacturer's written instructions.
7. Fiberglass Piping Bonded Joints: Use adhesive and procedure recommended by piping manufacturer.
8. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

   a. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
   b. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits

c. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.7 INSTALLATION OF VALVES

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.

C. UL-Listed or FM Global-Approved Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

D. UL-Listed or FM Global-Approved Valves Other Than Gate Valves: Comply with NFPA 24.

E. MSS Valves: Install as component of connected piping system.

F. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

G. Pressure-Reducing Valves: Install in vault or aboveground between shutoff valves. Install full-size valved bypass.

H. Relief Valves: Comply with AWWA C512. Install aboveground with shutoff valve on inlet.

I. Comply with requirements for concrete piers in Section 033000 "Cast-in-Place Concrete" for support of valves and piping not direct buried.

3.8 INSTALLATION OF DETECTOR-CHECK VALVES

A. Install in vault or aboveground.

B. Install for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.

C. Support detector check valves, meters, shutoff valves, and piping on brick or concrete piers. Comply with requirements of concrete piers in Section 033000 "Cast-in-Place Concrete."

3.9 INSTALLATION OF WATER METERS

A. Install water meters, piping, and specialties in accordance with utility company's written instructions.

B. Support water meters and piping NPS 3 and larger on concrete piers. Comply with requirements for concrete piers in Section 033000 "Cast-in-Place Concrete."

3.10 ROUGHING-IN FOR WATER METERS

A. Rough-in piping and specialties for water meter installation in accordance with utility company's written instructions.

3.11 INSTALLATION OF VACUUM BREAKER ASSEMBLIES

A. Install pressure vacuum breaker assemblies of type, size, and capacity indicated. Include valves and test cocks. Install in accordance with requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install pressure vacuum breaker assemblies in vault or other space subject to flooding.

3.12 INSTALLATION OF WATER METER BOXES

A. Install water meter boxes in paved areas flush with surface.

B. Install water meter boxes in grass or earth areas with top 2 inches above surface.

3.13 INSTALLATION OF CONCRETE VAULTS

A. Install precast concrete vaults in accordance with ASTM C891.

3.14 INSTALLATION OF PROTECTIVE ENCLOSURES

A. Install concrete base level and with top approximately 2 inches above grade.

B. Install protective enclosure over valves and equipment.

C. Anchor protective enclosure to concrete base.

3.15 INSTALLATION OF FIRE HYDRANTS

A. Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

B. Wet-Barrel Fire Hydrants: Install with valve below frost line. Provide for drainage.

C. AWWA Fire Hydrants: Comply with AWWA M17.

D. UL/FM Global Fire Hydrants: Comply with NFPA 24.

3.16 INSTALLATION OF FLUSHING HYDRANTS

A. Install post-type flushing hydrants with valve below frost line and provide for drainage. Support in upright position. Include separate gate valve or curb valve and restrained joints in supply piping.

B. Install ground-type flushing hydrants with valve below frost line and provide for drainage. Install hydrant box flush with grade. Include separate gate valve or curb valve and restrained joints in supply piping.

C. Install sampling stations with valve below frost line and provide for drainage. Attach weather-resistant housing and support in upright position. Include separate curb valve in supply piping.

3.17 INSTALLATION OF FIRE DEPARTMENT CONNECTIONS

A. Install ball drip valves at each check valve for fire department connection to mains.

B. Install protective pipe bollards on two sides of each fire department connection. Pipe bollards are specified in Section 055000 "Metal Fabrications."

3.18 INSTALLATION OF ALARM DEVICES

A. Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.

B. Supervisory Switches: Supervise valves in open position.

1. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
2. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.

C. Locking and Sealing: Secure unsupervised valves as follows:

1. Valves: Install chain and padlock on open OS&Y gate valve.
2. Post Indicators: Install padlock on wrench on indicator post.

D. Pressure Switches: Drill and thread hole in exposed barrel of fire hydrant. Install switch.

E. Water-Flow Indicators: Install in water-service piping in vault. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.

F. Connect alarm devices to building fire-alarm system. Wiring and fire-alarm devices are specified in [Section 284621.11 "Addressable Fire-Alarm Systems"] [Section 284621.13 "Conventional Fire-Alarm Systems."]

3.19 CONNECTIONS

A. See Section 330500 "Common Work Results for Utilities" for piping connections to valves and equipment.

B. Connect water-distribution piping to utility water main

C. Connect water-distribution piping to interior domestic water and fire-suppression piping.

D. Connect waste piping from concrete vault drains to sanitary sewerage system. See Section 221313 "Facility Sanitary Sewers" for connection to sanitary-sewer piping.

E. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.20 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.

1. Increase pressure in 50 psig increments and inspect each joint between increments. Hold at test pressure for one hour; decrease to 0 psig. Slowly increase again to test pressure and hold for one more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

3.21 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."

B. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Section 330500 "Common Work Results for Utilities" for identifying devices.

3.22 CLEANING.

A. Clean and disinfect water-distribution piping as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

    a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
    b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for three hours.
    c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
    d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 331415

SECTION 33 56 13

ABOVEGROUND FUEL-STORAGE TANKS

This Specification Section is from the ODOT Fuel Management Program

PART 1 - GENERAL

1.01 INTENT

A. The intent of this Specification is to have an above ground storage tank (AST) system (Single or Dual fuel) with a singular or aggregate capacity of (*TBD) gallons supplied. A complete AST system shall be defined as a functional AST system that meets all governing federal and state regulations. Contractor shall assemble all items, equipment, and accessories before delivery except for those items, equipment, and accessories that cause height/load restrictions to be exceeded, require removal prior to tightness testing, or may be damaged during transport if assembled prior to delivery, all of which the contractor shall assemble after delivery.

B. Fire Guard and Flame Shield tanks are the ONLY acceptable ASTs. The type of tank used will be dependent on the site layout and setback requirements from buildings and property line. This criteria should be taken into consideration when choosing the appropriate tank type.

1.02 SCOPE

A. Contractor shall be responsible for providing all equipment, labor, and materials necessary to fabricate cylindrical AST, and all equipment, labor and materials necessary to furnish, assemble, deliver, and unload the AST system. The AST system shall consist of a storage element and two (2) dispensing elements. A summary of AST system specified equipment is contained in Part 6.

1. The storage element shall consist of a two-hour fire rated above ground steel storage tank with 110% secondary containment (i.e., double wall tank) that is cylindrical in shape and is furnished with storage related equipment and accessories as outlined throughout this Specification. Storage related equipment and accessories shall include items that are necessary to store petroleum products and meet all governing federal and state regulations pertaining to such storage, and any additional storage related equipment.

2. The dispensing element shall consist of a UL-listed free standing dispenser unit with an internal mounted suction pump and related equipment and accessories as outlined throughout this Specification. Dispensing related equipment and accessories shall include items that are necessary to dispense petroleum products and meet all governing federal and state regulations pertaining to such dispensing.

3. Obtaining all regulatory approvals, permits and inspections for the AST system;

4. Paying all fees resulting from the approval, permitting, and inspection process;

5. Supplying anchor bolts and anchoring AST system to foundation.

B. Contractor shall be responsible for providing and installing the foundation pad and protective bollards.

C. Contractor shall be responsible for providing Equipment Notebooks as specified in Section 5.01 of this Specification that contain detailed diagrams, a listing of equipment and products, Manufacturer information and catalogue cut-sheets, and a list with instructions and diagrams that pertain to any anchoring, hook-ups, connections, procedures, etc. that are necessary to make the AST system complete and operational.

D. Contractor shall be responsible for having the AST system tested for tightness as specified in Section 5.04 of this Specification. The test shall be performed on site after delivery but before system start-up. Contractor will be responsible for making the necessary arrangements regarding test date and time with a testing company designated by the contractor, and for arranging to have the proper regulatory officials present for the testing.

E. Contractor shall be responsible for providing touch-up paint as specified in Section 5.03 of this Specification.

F. Contractor shall be responsible for providing volumetric tank charts as specified in Section 5.08 of this Specification.

1.03 STANDARDS

A. The fabrication, assembling, and furnishing of AST system shall adhere to the latest editions of the following standards and regulatory requirements:

1. Underwriters Laboratories

a. Standard for Steel Aboveground Storage Tanks, Standard UL 142, and

b. Standard for Insulated Secondary Containment, Protected Type Aboveground Storage Tanks, Standard UL 2085;

2. Protected Aboveground Tanks for Motor Vehicle Fuel-Dispensing Stations Outside Buildings, Appendix II-F, Uniform Fire Code, International Fire Code Institute;

3. Steel Tank Institute, Standard for Fireguard Thermally Insulated Aboveground Storage Tanks, #F941;

4. National Fire Protection Association

a. NFPA 30, Flammable and Combustible Liquids Code,

b. NFPA 30A, Automotive and Marine Service Station Code,

c. NFPA 70, National Electric Code, and

d. NFPA 704, Standard System for the Identification of the Hazards of Materials for Emergency Response;

5. National Fire Prevention Code, Building Officials and Code Administrators;

6. Standard Fire Prevention Code, Southern Building Code Congress International;

7. Clean Water Act and Oil Pollution Act of 1990, Spill Prevention, Control and Countermeasure (SPCC) Plans, 40 CFR 112, 113, and 114;

8. The Ohio Administrative Code

a. OAC Rule 1301:7 7 23,

b. OAC Rule 1301:7 7 28 (i.e., the Ohio Fire Code), and

c. OAC Rule 1301:7 7 44;

9. US Department of Labor, Occupational Safety & Health Administration

a. OSHA Standard Number 1910.21, Definitions,

b. OSHA Standard Number 1910.23, Guarding Floor and Wall Openings and Holes,

c. OSHA Standard Number 1910.24, Fixed Industrial Stairs.

10. American Society for Testing and Materials, ASTM Standard Specification for

a. C332 87 (1991)e1, Lightweight Aggregates for Insulating Concrete, and

b. A123 89ae1, Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

B. The delivery of AST system shall adhere to all governing DOT standards and regulations.

C. The unloading of AST system shall be in accordance with Manufacturer recommendations.

D. The assembling of items, equipment, and accessories by the contractor shall be in accordance with Manufacturer recommendations.

E. Tightness testing of the AST and AST system components shall be in accordance with respective Manufacturer recommendations.

1.04 SIZE

A. The size of the AST system is based upon the primary tank capacity and secondary tank outer dimensions.

1. Storage element capacity shall be the actual capacity that the primary tank can hold before the installation of any storage related equipment and/or accessories.

2. Storage element dimensions shall be the secondary tank outer dimensions.

B. AST system with sizes as shown in Table 1.04 B.

AST SYSTEM SIZE		
Storage Element CAPACITY	***Storage Element DIMENSIONS***	***Descriptive Name for Reference Purposes***
4,000 GAL	**288”L x 64”W x 64”H**	**DIESEL FUEL**
2,000 GAL	**144”L x 64”W x 64”H**	**UNLEADED FUEL**

TABLE 1.04 B

C. Capacity and dimensions may vary from Table 1.04 B of this Specification as follows:

1. Capacity may be smaller than capacity shown in Table 1.04 B by one percent (1%).

2. Capacity may exceed the capacity shown in Table 1.04 B by an unspecified amount;

3. Length and diameter may each vary by + 6 in. (plus or minus six inches) as long as the capacity shown in Table 1.04 B is not reduced by more than 1% (one percent).

1.05 USE

A. AST system will be used in conjunction with the following petroleum products as shown in Table 1.05 A (below):

AST SYSTEM USE	
Descriptive Name	***Intended Product or Products***
***TBD**	***TBD**

TABLE 1.05 A

B. The intended product for the single compartment AST system will be as shown in Table 1.05 A of this Specification unless specified otherwise when the AST system is ordered. The storage element shall be fabricated, furnished, assembled, etc. so the compartment is compatible for use with the intended product.

C. In the future, the Owner may want to change the use (i.e., product being stored) of a particular AST system. For this reason, the storage element for AST systems of the same size shall be identical regardless of use. For example, the fabrication, furnishing, assembling, etc. of the storage element of a 1,000 gallon AST system used to store diesel shall be the same as 1,000 gallon storage elements used for gasoline storage.

D. In case an AST system's use is changed, each AST system shall be fabricated, furnished, assembled, etc. so that it is compatible for use with any of the other intended products as shown in Table 1.05 A of this Specification. In other words, all systems shall be compatible for use with diesel, and gasoline.

1.06 STORAGE ELEMENT

A. The storage element of the AST system shall consist of an AST with the primarytank and the following storage related assemblies, equipment and accessories:

1. Venting assembly comprised of

   a. one (1) atmospheric vent

   b. one (1) emergency vent

   c. one (1) interstitial emergency vent, and

   d. vent piping for the atmospheric vent.

2. One (1) top fill assembly being comprised of

   a. fill/spill containment box,

   b. cam lock dust cap, and

   c. all in one fill/overfill prevention valve with drop tube.

3. Gauge and alarm equipment consisting of

   a. one (1) product level gauge with dip tube/drop tube float,

   b. one (1) audible overfill alarm, and

   c. one (1) interstitial leak detection gauge.

4. Grounding assembly comprised of

   a. grounding rod(s),

   b. grounding wire, and

   c. method of securing the grounding wire.

5. Two (2) additional openings with lockable tight caps or compatible plugs [two (2) four (4) inch openings in the primary tank];

6. Access assembly allowing access to the top of the AST at the joint fill area comprised of

a. a stairway to the top of the AST, and

b. a catwalk platform on top of the AST connected to the stairway that allows access to both fill assemblies, both pump out/stick ports, both audible overfill alarms, and the primary tank leak detection gauge that monitors the split.

B. The throughput for any AST system solicited through this Specification is not expected to exceed 10,000 gallons in any month or 120,000 gallons in any rolling 12 month period. Contractor will NOT be required to install stage I vapor recovery on any storage element.

C. Storage element for any AST system shall also include any storage related equipment and accessories not mentioned in this Specification but required by governing federal and state regulations.

1.07 DISPENSING ELEMENT

A. The dispensing element to be used with gasoline or diesel shall consist of a UL-listed free standing dispenser unit with an internal mounted suction pump and the following related equipment and accessories:

1. Piping assembly comprised of

a. product piping,

b. ball valve (2),

c. external fire valve,

d. solenoid valve,

e. pressure regulator valve (with a built in shear connection),

f. flex connector, and

g. pressure regulator return line.

h. ½-inch expansion relief valve.

2. Full cabinet dispenser with meter, built-in hose retractor, and illuminated panel;

3. Hose assembly comprised of

a. fuel filter base,

b. fuel filter,

c. hose,

d. hose breakaway device,

e. swivel, and

f. nozzle.

4. Metal dispenser pedestal.

B. The throughput for any AST system solicited through this Specification is not expected to exceed 10,000 gallons in any month or 120,000 gallons in any rolling 12 month period. Contractor will NOT be required to install stage II vapor recovery on any dispensing element.

C. Dispensing element for any AST system shall also include any dispensing related equipment and accessories not mentioned in this Specification but required by governing federal and state regulations.

PART 2 - STORAGE ELEMENT

2.01 ABOVE GROUND STORAGE TANK

A. AST shall meet the Steel Tank Institute's designation of Fire Guard or Flame Shield Aboveground Tank (no equivalents accepted) for the storage of petroleum products at or near atmospheric pressure. For FLAMESHIELD based designs, the Double Walled Steel AST body will meet U.L. 142, Underwriters Laboratories, Inc., Steel Aboveground Tanks for Flammable and Combustible Liquids. For FIREGUARD based designs. AST body, in addition to U.L. 142, will also meet U.L. 2085, Underwriters Laboratories 2 Hour Fire Rating's Standard for Insulated Aboveground Storage Tanks for Flammable and Combustible Liquids. Choice of tank will be dependent on tank siting and setback requirements listed in NFPA 30 and the Ohio Fire Code.

1. Provide tank manufactured by Modern Welding, Newark, Ohio; Hamilton Tank, Columbus, Ohio; Stanwade Metal Products, Hartford, Ohio; or Highland Tank, Stoystown, Pennsylvania.

2. The primary and secondary tanks shall be cylindrical in shape and manufactured in accordance with Steel Tank Institute Publication #F941 94, "Standard for Fireguard Thermally Insulated Above Ground Storage Tanks."

3. The listed assembly shall meet the requirements for "protected" tank as defined by the UFC Appendix II-F as of 10/3/97, and "fire resistant" tank as defined by Underwriters Laboratories including impact resistance, ballistics protection, and hose stream resistance criteria as of 10/3/97.

4. Each AST shall consist of an inner steel wall, encased by lightweight thermal insulation material, and an outer steel wall.

5. The outer steel wall shall be UL 2085 listed as of 10/3/97 for secondary containment, and capable of providing a minimum of 110% containment of the primary storage tank's contents.

6. A legible UL 2085 label shall be affixed to the side of each AST. If UL 2085 changes, the subsequent UL listing required by the Steel Tank Institute for Fireguard ASTs shall be displayed.

7. Steel outer wall of each AST shall be painted to prolong weather resistance and to further reduce maintenance needs. The color of the paint shall be white. The type of paint shall be Acrylathane 85 by Madison Chemical Industries, or equivalent.

B. AST shall be designed for use aboveground and include integral secondary containment, and three inches (3 in.) of thermal insulation that provides a minimum two-hour fire rating.

1. The thermal insulation shall be a porous, lightweight monolithic thermal insulation material in the AST's interstitial space.

2. The thermal insulating material shall allow liquid to migrate through the interstice to a monitoring point.

3. The thermal insulation material shall not be exposed to weathering and shall be protected by the steel secondary containment outer wall.

4. Thermal insulation material shall be installed at the factory and be in accordance with ASTM Standard Specification C332 87 (1991)e1.

C. During AST construction, provisions shall be made such that items specified to be bolted or secured to the AST can be bolted or secured to the AST (i.e., catwalk platform is to be bolted to the AST, product piping is to be secured to the end of the AST in two (2) places, etc.).

D. The single use AST shall have the primary tank

1. The tank shall be made using a carbon steel.

a. The primary tank shall be a minimum of a quarter inch (1/4 in.) thick.

b. The secondary shell shall be a minimum of a quarter inch (1/4 in.) thick.

E. Each AST shall have an interstitial monitoring tube between the primary tank and secondary tank to be used for monitoring the interstice for liquids. In addition, a monitoring tube in the primary tank between the bulkheads used to split the primary tank into compartments so that the potential for product mixing can be monitored.

1. Interstitial monitoring tube shall access the AST monitoring point required by Section 2.01 B.2 of this Specification.

2. Primary tank monitoring tube shall access the clear space between bulkheads as required by Section 2.04 E of this Specification.

F. All ASTs shall be constructed such that each AST has the appropriate number and sizes of openings for the required accessories and equipment, and as required by this Specification.

1. All openings shall be made through the top of the AST with no exceptions.

2. An eight-inch by eight-inch by one-quarter inch (8 in. x 8 in. x 1/4 in.) thick striker plate shall be installed under each pump out/stick port opening.

3. A thirty-inch by thirty-inch by one-quarter inch (30 in. x 30 in. x 1/4 in.) thick striker plate shall be installed under each manway.

G. Provide two (2) additional openings as mentioned in Section 1.06 A.5 and outlined in Section 2.06 of this Specification.

H. Primary and secondary tank shall be constructed of one-quarter inch (1/4 in.) metal or thicker.

I. All bulkheads and bulkhead installation shall be in accordance with UL 142. Bulkheads that are less than five-sixteenths of an inch (5/16 in.) thick shall be braced.

J. For the purposes of this Specification, an AST shall consist of a double-wall tank with two (2) supports (i.e., saddles). The tank and supports shall be delivered together as a complete UL-listed assembly. The bottom member of each support shall extend past the vertical members on each side of the support by six inches (6 in.) or until the length of each bottom member equals the secondary tank outer diameter, whichever has the lesser length. The supports shall come complete with pre-drilled anchoring holes and potential grounding holes that are drilled before painting so that the exposed drilled area gets painted.

1. The bottom member of each support shall have two (2) holes that will be used for anchoring the AST to the foundation, for a total of four (4) anchoring holes per AST.

a. Anchor holes shall be located in each of the four (4) portions of the bottom members that extend past the vertical members of the supports. Each hole shall be centered in the extended portion that it is located in.

b. One support shall have round holes and the other support shall have slotted (elliptical) holes to allow for expansion and contraction.

1) Round holes shall be one and one-eighth inch (1 1/8 in.) in diameter.

2) Slotted holes shall be one and one-eighth inch (1 1/8 in.) wide by two inches (2 in.) long, with the long dimension running parallel to the length of the AST.

2. Unless recommended differently by the contractor before AST fabrication, each of the four (4) vertical members of the supports shall have a hole to potentially be used for grounding the AST.

a. Grounding holes shall be round, and the size of the hole shall be left up to the discretion of the contractor.

b. Not all holes will actually be used, but having four (4) potential grounding connection points located in different portions of the AST will allow flexibility in choosing the most logical direction or directions to ground from.

c. Contractor will be responsible for scuffing the paint off the exterior of any holes chosen for grounding.

3. AST lifting lugs shall be multi-use lugs that are non-removable and permanently installed. Temporary, disposable, single-use, and/or thread-in lifting lugs will not be permitted.

2.02 VENT ASSEMBLY

A. All vents, venting, vent piping, and vent installation shall comply with OFC 1301:7 7 28 and all applicable sections of the fire and mechanical code, including but not limited to the following:

1. NFPA 30A 2 1.2, 2 4.5 and chapter 3;

2. NFPA 30 2 3.5, 2 3.6, 2 3.7, and chapter 3;

3. UFC 7902.1.10, 7902.2.6, and Appendix II-F 5.3;

4. UL 142; and

5. UL 2085.

B. Vents and vent piping shall be constructed and/or coated to be corrosion resistant.

C. Vents and vent piping shall be compatible for use with gasoline, and diesel.

D. Vents shall be installed as close to the center of the AST or compartment as practical.

E. Primary tank vent shall be OPW 23-0033 atmospheric vent or equivalent, and shall be such that the vent:

1. Is protected from the intrusion of rain and foreign objects;

2. Discharges vapors upward or laterally; and

3. Is delivered with adequate vent piping to achieve a minimum distance of twelve feet (12 ft.) between ground surface and vent discharge height.

F. Emergency vents shall be Morrison Brothers 244 series emergency vents or equivalent. Emergency vents for primary tank and split tank compartments shall be constructed of iron (i.e., 244I series). Emergency vents for interstitial space may require nipples. Emergency vent selection shall take into consideration the possibility of product switching as mentioned in Section 1.05 C and Section 1.05 D of this Specification (i.e., emergency vents shall be tentatively sized for unleaded gasoline, and diesel, and the worst case scenario of those two shall be chosen). All emergency vents shall be such that each vent

1. Provides emergency pressure relief that begins at or after one (1) pound/square inch of pressure and is fully opened at or before two and one-half (2 1/2) pounds/square inch of pressure;

2. Has visible markings indicating the relief setting and venting capacity when fully opened; and

3. Has the required venting capacity (Cubic Feet of Free Air per Hour or CFH) calculated in accordance with NFPA 30, Section 2 3.6.4 and Table 2 8.

a. Required venting capacities for all sizes of AST systems that are being supplied and are in accordance with NFPA 30, Section 2 3.6.4 and table 2 8. These calculations assume all tank shapes are cylindrical and are based upon:

1) Secondary tank outer dimensions as shown in Table 1.04 B of this Specification, and

2) The assumption that there is a uniform six inches (6 in.) between the outer wall of the primary tank and inner wall of the secondary tank.

b. Contractor shall be responsible for calculating vent capacities and for submitting these calculations to the Owner upon request.

1) Compartment tank emergency vents on dual use ASTs shall be sized according to the configuration and capacity of the respective compartment.

2) All interstitial emergency vents shall be sized according to the configuration and capacity of the secondary tank.

G. Vent piping shall be two inch (2 in.) diameter piping that is constructed of steel or nodular iron. Galvanized vent piping is not acceptable.

1. Vent piping shall be of adequate length to achieve a minimum distance of twelve feet (12 ft.) between ground surface and vent discharge height.

2. Vent piping shall be threaded both ends (T.B.E.).

3. The AST shall be constructed such that it includes a pipe nipple and coupling assembly or equivalent threaded mounting assembly for rigidly and durably securing the vent piping in place on top of the AST.

2.03 FILL ASSEMBLY

A. All storage elements solicited through this Specification shall be filled from the top.

B. All fill equipment and the installation of fill equipment shall comply with OFC 1301:7 7 28, particularly FM 2803.2.2, and all applicable sections of the fire and mechanical code, including but not limited to the following:

1. NFPA 30A 2 4.6.1, 2 4.9, and 3 6;

2. NFPA 30 2 3.8 and 3 9; and

3. UFC Appendix II-F 5.6 and 5.7.

C. Fill components shall be constructed and/or coated to be corrosion resistant.

D. All fill components shall be compatible for use with gasoline, and diesel.

E. Fill components shall be installed within their respective compartment as close as possible to where the splitting of the primary tank takes place. All fill components shall be obtainable from the access assembly as required by Section 1.06 A.6.b of this Specification.

F. Fill/spill containment box shall be designed specifically for use with ASTs and shall have the following:

1. Hinged lid with lockable hasp;

2. Built-in spill return device; and

3. Five (5) gallon minimum capacity.

G. Fill cap shall be a two-inch (2 in.) cam lock dust cap.

H. Fill/overfill prevention valve shall be a two inch (2 in.) valve designed specifically for use with ASTs, and shall be an OPW 61fstop 2 in., Morrison Brothers 9095 A 2 in., or Clay and Bailey F 30 2 in.. Fill/overfill prevention valve shall have the following:

1. Mounting hardware;

2. Two inch (2 in.) diameter fill with fill pipe that terminates within six inches (6 in.) from the bottom of the primary tank or compartment, and is cut at the bottom at a 45 degree angle with the open end of the cut drop tube facing in the direction where dispensing withdrawal will occur;

3. Two inch (2 in.) cam lock fill adaptor;

4. Cushioned positive shut-off at 95% capacity of primary tank or compartment.

2.04 GAUGE AND ALARM EQUIPMENT

A. Gauges and alarms shall be constructed and/or coated to be corrosion resistant.

B. Gauges and alarms shall be compatible for use with gasoline, and diesel.

C. All gauge and alarm equipment and the installation of gauge and alarm equipment shall comply with OFC 1301:7 7 28, particularly FM 2803.2.2, and all applicable sections of the fire and mechanical code, which includes but is not limited to the following:

1. NFPA 30A 2 4.6.1; and

2. NFPA 30 2 3.8.

D. Product level gauge and audible overfill alarm shall be a Morrison Brothers 918 clock gauge with alarm unit, or equivalent.

1. Product level gauge shall be a non-electric top mounted mechanical clock face gauge.

a. Gauge shall give product readings in feet and inches, and shall be set to give the same readings that one should get when sticking the tank through the pump out/stick port outlined in sections 2.6 B) through 2.6 B) 2 [c] of this Specification (i.e., the gauge should be set so that it reads 0 feet and 0 inches at 1/4 in. above the bottom of the primary tank to account for the quarter inch thick striker plate under the pump out/stick port opening).

b. Gauge shall be visible and readable to the nearest one-eighth inch (1/8 in.) from a distance of twenty feet (20 ft.) away.

c. Gauge shall be installed on top of the AST in the vicinity of the fill area such that it is clearly visible and readable to personnel filling or sticking the AST.

2. Float for product level gauge shall be installed inside a dip tube or drop tube to minimize float drifting and tangling.

a. Float shall be a drop tube float made specifically for installation inside a dip tube/drop tube (option #5 on the Morrison Clock Gauge).

b. Provisions shall be made to keep localized pressure and/or vacuum from building up within the dip tube/drop tube and interfering with float operation. This can be accomplished with a one-half inch (1/2 in.) diameter hole in the dip tube/drop tube where the location of the hole is above the 95% capacity level but below the top of the primary tank or compartment.

3. Audible overfill alarm unit shall be a non-electric intrinsically safe battery operated alarm unit that is mounted remote from the product level gauge.

a. Audible alarm warning shall be set at 90% of the AST's capacity.

b. Audible alarm unit shall be attached to the catwalk railing nearest to the fill that the alarm corresponds to and in such a manner that the height of the alarm unit is at or below the top railing but above the intermediate railing.

E. Interstitial leak detection gauge shall be the AT-A-GLANCE Leak Gauge made by Krueger Sentry Gauges, or equivalent.

1. Interstitial leak detection gauge shall be a non-electric top mounted mechanical gauge that visually indicates a leak through a float and bobber type system.

a. Gauge shall be installed on top of the AST at the monitoring tube between the primary tank and secondary tank as required by Section 2.01 E of this Specification.

b. Gauge float shall penetrate the interstice by being installed through the monitoring tube that accesses the monitoring point as required by Section 2.01 B.2 of this Specification.

c. The gauge, monitoring tube, and monitoring point shall be located at either end of the AST.

d. Gauge shall be set to start detecting liquid within the interstice when the liquid level at the monitoring point is twelve inches (12 in.) in depth. A twelve inch (12 in.) depth will allow a condensation and evaporation cycle with minimal false leak indications that does not compromise the ability of the gauge to detect a breach in the primary tank.

e. The indicator portion of the gauge shall be installed such that it is visible from twenty feet (20 ft.) away from the end of the AST in which it is installed.

2.05 GROUNDING ASSEMBLY

A. All grounding and grounding equipment shall comply with OFC 1301:7 7 28, particularly F 2803.8, and NFPA 70.

B. Grounding assembly shall provide protection against

1. Lightning damage; and

2. Static discharge, particularly during unloading of transport vehicle.

C. Contractor shall be responsible for determining the number of grounding points and location of grounding points on the storage element.

1. Contractor will be responsible for the following regarding grounding of the AST:

a. The storage element has continuity and will only require one (1) grounding point; and

b. Each of the four (4) holes mentioned as potential grounding connection points in Section 2.01 J.2 of this Specification is a valid grounding point.

D. Each required grounding point shall require a grounding assembly consisting of a grounding rod, ten feet (10 ft.) of grounding wire, a method for securing the grounding wire, and/or any other equipment and materials recommended by the contractor.

1. Grounding rods shall be five-eighths inches (5/8 in.) in diameter by eight feet (8 ft.) in length.

2. Grounding wire shall be #4 solid bare copper wire.

3. Method for securing grounding wire shall include all equipment necessary to secure the wire to the AST and to the grounding rod. Method must provide a durable connection. Alligator clips will not be accepted.

E. Contractor shall be responsible for ensuring that the entire AST system has an appropriate grounding method to protect against lightning damage and static discharge. Contractor shall be responsible for notifying the Owner in writing on or before AST system delivery if any portion of the grounding requirements as mentioned in sections 2.05 C through 2.05 D.3 of this Specification will not provide the desired protection and/or meet state and federal regulations pertaining to the grounding of AST systems.

F. If the contractor feels that the grounding requirements are not adequate as mentioned in Section 2.05 E of this Specification, or if the contractor prefers an alternative method that will provide equal or greater protection, the contractor may use additional grounding measures and/or an alternative grounding method if prior approval is granted by the Owner.

2.06 ADDITIONAL OPENINGS

A. Each AST shall have two (2) additional openings as mentioned in Section 2.01 G of this Specification.

1. Additional openings shall be other than those openings and/or manways that are
   a. Required by state and federal law;
   b. Necessary for AST equipment and accessories installation to make the AST system a complete system;
   c. Required during AST construction for insulation filling and viewing, and
   d. Required by the Steel Tank Institute (STI) regarding the fabrication of Fireguard ASTs.
2. The additional openings shall be pipe nipples threaded one end (T.O.E.) that penetrate the primary tank.
3. Additional openings shall be as follows:
   a. Each AST shall have two four inch (4 in.) diameter additional openings.

B. Four inch (4 in.) diameter openings located at each end of the tank shall be considered as the pump out/stick port mentioned is sections 1.06 A.5 of this Specification.

1. The pump out/stick port must be obtainable from the access assembly as mentioned in Section 1.06 A.6.b of this Specification.
2. The pump out/stick port shall have a lockable tight cap and a four inch (4 in.) diameter dip tube or drop tube.
   a. Dip tube/drop tube shall terminate within six inches (6 in.) of the bottom of the primary tank or compartment.
   b. Provisions shall be made to keep localized pressure and/or vacuum from building up within the dip tube/drop tube and interfering with manual sticking procedures. This can be accomplished with a one-half inch (1/2 in.) diameter hole in the dip tube/drop tube where the location of the hole is above the 95% capacity level but below the top of the primary tank or compartment.
   c. An eight-inch by eight inch by one-quarter inch thick (8 in. x 8 in. x 1/4 in.) striker plate as mentioned in Section 2.01 F.2 of this Specification shall be located under the pump out/stick port.

2.07 ACCESS ASSEMBLY

The platform and staircase specification listed below are designed as parts of an unoccupied equipment platform and access way as defined in the Ohio Building Code (OBC) Sections 502.1 and 505.5. The platform and staircase are not considered part of the means of egress, and are not required to meet the provisions of OBC Section 1009. The platform and staircase design listed below meet the applicable OSHA requirements.

A. Access assembly shall be designed, constructed, and installed in accordance with OSHA standards, particularly standard numbers 1910.21, 1910.23, and 1910.24. Access assembly may be pre-fabricated, or be fabricated by contractor, or be any combination of both. Access assembly shall include the following:

1. Supported metal catwalk platform on top of the AST for access to specified items;
2. Self-supporting metal stairway assembly to allow egress to and from the catwalk platform; and

3. Any other item or equipment that conforms to OSHA standards and is

   a. necessary to allow egress to and from the top of the AST,

   b. necessary to allow access to specified items on top of the AST, and

   c. required by OSHA or any other state or federal regulatory authority.

B. Access assembly, with the possible exclusion of bolts, nuts, and washers, shall be constructed of carbon steel. All items and surfaces, including surfaces exposed by drilling holes, that constitute the access assembly after fabrication and/or construction of the access assembly is complete, excluding items welded to the exterior of the AST such as fixed supports and mounting brackets required by sections 2.07 E.1 and 2.07 E.2 of this Specification, and excluding nuts, bolts, and washers, shall be hot-dip galvanized for corrosion protection after the fabrication and/or construction of the access assembly is complete. Hot-dip galvanizing shall be in accordance with ASTM Standard Specification A123 89ae1.

   1. Fixed supports and mounting brackets required by sections 2.07 E.1 and 2.07 E.2 of this Specification that are welded to the AST shall not be galvanized and shall be protected from corrosion by being painted white using the same paint specified in Section 2.01 A.7 of this Specification that is used to paint the AST.

C. All bolts, nuts, and washers used in conjunction with the access assembly shall be constructed and/or factory coated be corrosion resistant (i.e., the bolts, nuts, and washers must be galvanized, or constructed of stainless steel, or have some type of equivalent method of corrosion resistance applied at the factory). All load bearing bolts shall be 10,000 PSI minimum shear bolts.

D. All portions of the access assembly that will have foot traffic shall have slip-resistant, grated, serrated surfaces that do not allow water, snow, or ice to accumulate.

E. Provisions shall be made during AST construction for securing the catwalk platform in place on top of the AST. A total of four (4) attachment points will be required on top of the AST.

   1. Two (2) fixed supports shall be welded to the AST such that the location of the fixed supports correspond with the two (2) corners of the catwalk platform that are furthest from the entrance to the catwalk platform.

      a. Each fixed support shall be constructed of a three inch by three inch by one-fourth inch thick (3 in. x 3 in. x 1/4 in. thick) steel angle.

      b. Each fixed support shall have two (2) seven-eighths inch (7/8 in.) diameter holes near the protruding end for bolting the catwalk platform to the fixed supports with two (2) three-fourths inch (3/4 in.) diameter bolts. A minimum of one-half inch (1/2 in.) of metal must be maintained around the holes.

   2. Two (2) mounting brackets shall be welded to the AST exterior in the quadrant that is nearest to the catwalk platform opening. Mounting brackets will be used in conjunction with knee braces, and shall be located such that the vertical centerline of the AST and a line extending from the center of the AST to the mounting bracket is approximately sixty (60) degrees.

      a. Each mounting bracket shall have a round hole and a slotted hole for bolting a knee brace to the mounting bracket. The round hole shall be located such that it is below the slotted hole and closer to the AST exterior. A minimum of one-half inch (1/2 in.) of metal must be maintained around the holes.

         1) The round hole shall have a diameter of seven-eighths inches (7/8 in.).

2) The slotted hole shall be two inches (2 in.) long in the horizontal direction and seven-eighths inches (7/8 in.) wide.

b. Each knee brace shall consist of a three inch by three inch by one-fourth inch thick (3 in. x 3 in. x 1/4 in. thick) steel angle that has a round hole and a slotted hole in the lower end for bolting the knee brace to the mounting bracket using two (2) three-fourths inch (3/4 in.) diameter bolts, and two (2) round holes in the upper end for bolting the knee brace to the catwalk platform frame using two (2) three-fourths inch (3/4 in.) diameter bolts. A minimum of one-half inch (1/2 in.) of metal must be maintained around bolt holes.

1) Each round hole shall have a diameter of seven-eighths inches (7/8 in.).

2) The slotted hole shall be one and one-half inches (1 1/2 in.) long in the vertical direction and seven-eighths inches (7/8 in.) wide.

3) The round hole in the lower end shall be below the slotted hole.

3. The method of securing the catwalk platform frame to the top of the AST shall be designed, constructed, and installed such that each point of attachment, including but not limited to welds, fixed supports, mounting brackets, knee braces, bolts, and any other methods and materials used, has the strength to support a moving concentrated load of at least one-thousand pounds (1,000 lbs.) [OSHA 1910.24 (c)]. Load bearing bolts shall be 10,000 PSI minimum shear bolts.

F. Catwalk platform shall consist of a frame, standard railing, and a floor, and have a thirty-six inch (36 in.) wide entrance as measured between the toeboard on either side of the entrance.

1. Catwalk platform frame shall be constructed of three inch by five inch by one-fourth inch thick (3 in. x 5 in. x 1/4 in. thick) steel angles that are welded or bolted together with the five inch (5 in.) legs in the vertical plane, and at least one (1) and possibly more than one (1) middle support where each middle support consists of a three inch by three inch by one-fourth inch thick (3 in. x 3 in. x 1/4 in. thick) steel angle that is welded or bolted to the two (2) outer frame angles perpendicular to the tank length.

a. The bolting together of any portion of the frame will require two (2) seven-eighths inch (7/8 in.) diameter holes and two (2) three-fourths inch (3/4 in.) diameter bolts at each point where bolting will occur. A minimum of one-half inch (1/2 in.) of metal must be maintained around all holes.

b. The three (3) sides of the frame that do not contain the catwalk platform entrance shall have the five inch (5 in.) leg of the steel angle protruding upward as toeboard [OSHA 1910.23 (c) (1)].

c. The side of the frame that contains the catwalk platform entrance shall have the five inch (5 in.) leg of the steel angle protruding downward [OSHA 1910.23 (c) (1)] and have two (2) slotted holes for bolting the frame to the stairway platform frame using two (2) three-fourths inch (3/4 in.) diameter bolts.

1) Bolt holes shall be seven-eighths inches (7/8 in.) wide, two inches (2 in.) long in the vertical direction, and located in the vertical leg at opposite ends but within the span of the opening. A minimum of one-half inch (1/2 in.) of metal must be maintained around the holes.

d. If the side containing the catwalk platform entrance exceeds thirty-six inches (36 in.), an additional three inch by five inch by one-fourth inch thick (3 in. x 5 in. x 1/4

in. thick) steel angle will be required for toeboard along the portion of that side that is not intended to be part of the entrance [OSHA 1910.23 (c) (1)].

1) The additional steel angle shall be welded or bolted to the frame. Bolting will require a bolt hole and a bolt in each end for a total of two (2) seven-eighths inch (7/8 in.) diameter holes and two (2) three-fourths inch (3/4 in.) diameter bolts per additional steel angle.

e. Frame, including but not limited to all welds, bolts, and materials, shall be designed, constructed, and installed to support a moving concentrated load of at least one-thousand pounds (1,000 lbs.) [OSHA 1910.24 (c)]. Load bearing bolts shall be 10,000 PSI minimum shear bolts.

f. Each of the two (2) steel frame angles that are perpendicular to the side with the catwalk platform opening shall have four (4) bolt holes for a total of eight (8) holes in the catwalk platform frame that are used for bolting the frame in place above the AST. Two (2) of the holes in each steel angle shall be used for bolting the frame to fixed supports and the remaining two (2) holes in each steel angle shall be used for bolting the frame to knee braces. Instead of placing all holes in the frame, the contractor may place some or all holes in clips that are welded or bolted to the bottom of the frame. The bolting of a clip to the frame will require two (2) seven-eighths inch (7/8 in.) diameter holes and two (2) three-fourths inch (3/4 in.) diameter bolts per clip (a bolt and hole in each end of the clip) to secure the clip to the frame. A minimum of one-half inch (1/2 in.) of metal must be maintained around all holes.

1) Holes shall be horizontally slotted, and shall be seven-eighths inches (7/8 in.) wide and three inches (3 in.) long. There shall be two (2) holes near each end of each of the two (2) steel frame angles that are perpendicular to the catwalk platform opening, and the pair of holes near each end shall be situated such that one (1) hole is directly above the other hole. The purpose of having slotted holes is to allow for minor adjustments so that the catwalk platform floor height can be matched up with the stairway platform floor height.

2) A total of eight (8) three-fourths inch (3/4 in.) diameter bolts shall be used to bolt the frame and/or clips already attached to the frame to the fixed supports and knee braces. Bolting shall be such that there are two (2) bolts per fixed support and two (2) bolts per knee brace.

g. Each middle support shall have the vertical leg protruding downward, and shall be used to provide support for bearing bar clear spans exceeding thirty-four inches (34 in.) and support to the catwalk platform floor in the area where equipment protrusion will occur.

1) A middle support shall be located at least one inch (1 in.) but no more than two inches (2 in.) away from the edge of the largest equipment cut-out in the catwalk platform flooring, and in such a manner that the support is between the cut-out and catwalk platform entrance.

h. The catwalk platform frame shall have a minimum of four (4) nine-sixteenths inch (9/16 in.) diameter holes for bolting the catwalk platform floor in place using one-half inch (1/2 in.) diameter bolts. If the catwalk platform floor consists of two (2) square or rectangular pieces of open steel floor grating, then a minimum of eight (8) holes will be required. A

minimum of one-half inch (1/2 in.) of metal must be maintained around all holes.

i. A minimum of three inches (3 in.) shall be maintained between all components of the catwalk platform frame and the outer shell of the AST.

j. The outer edge of the frame at the catwalk platform opening shall extend three inches (3 in.) past the perimeter of the AST outer shell in the horizontal direction.

2. Catwalk platform railing shall consist of top railing, intermediate railing, and posts [OSHA 1910.23 (e) (1)]. All railing shall be constructed of one and one-half inch (1 1/2 in.) diameter schedule 40 steel pipe [OSHA 1910.23 (e) (3) (ii)] that is welded together. All railing surfaces shall be smooth [OSHA 1910.23 (e) (1) requires smooth top railing].

a. Top railing shall be installed around the perimeter of the catwalk platform except at the entrance [OSHA 1910.23 (c) (1)], and shall have a vertical height of forty-two inches (42 in.) as measured from the catwalk platform floor top surface to the top surface of the railing [OSHA 1910.23 (e) (1)].

b. Intermediate railing shall be installed around the perimeter of the catwalk platform except at the entrance [OSHA 1910.23 (c) (1)], and shall have a vertical height of twenty-one inches (21 in.) as measured from the catwalk platform floor top surface to the center of the railing [OSHA 1910.23 (e) (1)].

c. Posts shall be installed at each corner of the catwalk platform, every eight feet (8 ft.) or less along continuous top railing and/or intermediate railing spans [OSHA 1910.23 (e) (3) (ii)], and on either side of the entrance to the catwalk platform. Single use catwalk platforms will require at least four (4) posts and dual use catwalk platforms will require at least five (5) posts.

d. Posts shall be welded and/or bolted to the catwalk platform frame. Whenever possible, posts shall be secured to the outside of the frame.

1) If posts are bolted instead of welded, two (2) seven-eighths inch (7/8 in.) diameter holes and two (2) three-fourths inch (3/4 in.) diameter bolts will be required for securing each post. A minimum of one-half inch (1/2 in.) of metal shall be maintained around all bolt holes.

e. Catwalk platform railing shall be designed, constructed, and installed such that all railing, including all welds used to connect top railing, intermediate railing, and posts together, and all welds and/or bolts used to secure posts to the catwalk platform frame, has the strength to support a load of at least two-hundred pounds (200 lbs.) applied in any direction at any point on the top railing [OSHA 1910.23 (e) (3) (iv)]. All bolts shall be 10,000 PSI minimum shear bolts.

f. Provisions shall be made for attaching audible overfill alarm units to the catwalk platform railing such that the height of the alarm unit is at or below the top railing but above the intermediate railing.

3. Catwalk platform floor shall consist of open steel floor grating that is constructed of carbon steel and has a standard mesh (i.e., type 19W2), serrated surface, cross bars that are spaced two inches (2 in.) on center, and one and one-fourth inch (1 1/4 in.) deep by three-sixteenths inch (3/16 in.) wide bearing bars that are spaced a maximum of one and three-sixteenths inches (1 3/16 in.) on center so that the gaps between nearest edges are one inch (1 in.) or less and do not meet OSHA's definition of a floor hole [OSHA 1910.21 (a)

(1)] and do not require extra protection [OSHA 1910.23 (a) (8) through (9)]. Floor shall be installed with the bearing bars perpendicular to the AST length.

a. Contractor shall use one (1) continuous piece of open steel floor grating for the catwalk platform floor unless the width and length of the platform both exceed thirty-six inches (36 in.). If catwalk platform width and length both exceed thirty-six inches (36 in.), the contractor will be permitted to use two (2) pieces of open steel floor grating. The use of more than two (2) pieces of open steel floor grating for the floor will require prior approval from the Owner.

1) Each piece of open steel floor grating used for catwalk platform flooring shall be square or rectangular in shape, and shall have a one-fourth inch (1/4 in.) thick steel tab welded in each corner (four [4] tabs per each piece) for securing the grating to the catwalk platform frame.

a) Each steel tab shall have a nine-sixteenths inch (9/16 in.) diameter hole in the center of the tab to be used for bolting the grating to the frame with one-half inch (1/2 in.) diameter bolts. A minimum of three-sixteenths inch (3/16 in.) of metal must be maintained around the tab hole.

2) When more than one (1) piece of open steel floor grating is used, the separate pieces shall be fastened together at the seam where the pieces abut. Additional supports may also be required under seams.

b. Catwalk platform floor shall have cut-outs (i.e., holes) to allow the protrusion of specified equipment through the floor so that the equipment is accessible.

1) The catwalk platform floor of a single use AST shall have cut-outs for the fill assembly and the pump out/ stick port for a total of two (2) cut-outs, and the catwalk platform floor of a dual use AST shall have cut-outs for both fill assemblies, both pump out/stick ports, and the primary tank leak detection gauge monitoring the tank split for a total of five (5) cut-outs.

a) Fill assemblies and pump out/stick ports shall protrude through and at least two inches (2 in.) above the catwalk platform floor.

b) Primary tank leak detection gauges shall protrude through and above the catwalk platform floor such that the indicator portion of the gauge is visible to someone standing on the catwalk platform.

2) The gap between the perimeter of a cut-out and the perimeter of equipment as it protrudes through the cut-out shall be at least one-half inch (1/2 in.) wide but no more than one inch (1 in.) wide so that the gap does not meet OSHA's definition of a floor hole [OSHA 1910.21 (a) (1)] and does not require extra protection [OSHA 1910.23 (a) (8) through (9)].

3) The distance between the perimeter of cut-outs and the outer edges of any piece of open steel floor grating used as catwalk platform flooring shall be four inches (4 in.) or greater.

a) At least two (2) continuous (i.e., uncut) cross bars shall be located between all cut-out perimeters and the flooring outer edge that is furthest away from the catwalk platform entrance.

4) The distance between the perimeters of adjacent cut-outs shall be at least three inches (3 in.).

5) The distance between the perimeter of the nearest cut-out and the edge of the catwalk platform frame middle support that provides support in the area of the cut-outs shall be at least one inch (1 in.) but no more than two inches (2 in.).

c. Catwalk platform floor shall be designed, constructed, and installed to support a moving concentrated load of at least one-thousand pounds (1,000 lbs.) [OSHA 1910.24 (c)].

4. Catwalk platform shall be designed, constructed, and installed such that it is square or rectangular in shape [OSHA 1910.24 (g) requires platform width to equal or exceed stair width and platform length to be at least thirty inches (30 in.)], and does not extend over tank openings other than those required to be obtainable from the access assembly.

G. Stairway shall consist of stairs and a stairway platform at the top of the stairs.

1. Stairs shall consist of treads welded to clips that are welded to stringers, and stair railing.

a. Treads, clips, and stringers shall be designed, constructed, and installed such that the incline angle (i.e., angle between the ground and stringers) is at least forty-five (45) degrees but no more than fifty (50) degrees [OSHA 1910.24 (e) requires a minimum of thirty (30) degrees and a maximum of fifty (50) degrees].

1) Each tread shall consist of a single rectangular piece of open steel floor grating that is constructed of carbon steel and has a standard mesh (i.e., type 19W2), serrated surface, cross bars spaced at two inches (2 in.) on center, and one and one-fourth inch (1 1/4 in.) deep by three-sixteenths inch (3/16 in.) wide bearing bars spaced no more than one and three-sixteenths (1 3/16 in.) on center so that the gaps between nearest edges of the bearing bars are one inch (1 in.) or less and do not meet OSHA's definition of a floor hole [OSHA 1910.21 (a) (1)] and do not require extra protection [OSHA 1910.23 (a) (8) through (9)].

a) Each tread shall be installed such that it is in the horizontal plane with the bearing bars perpendicular to the stringers.

b) Nosings will only be required if the leading edge of treads are not readily identifiable by persons descending the stairs [OSHA 1910.24 (f)].

2) Clips shall consist of two inch by two inch by one-fourth inch thick (2 in. x 2 in. x 1/4 in. thick) steel angles. Two (2) clips will be required for each tread. The clip length shall equal or exceed the tread width as specified in Section 2.07 G.1.c.3) of this Specification.

3) Stringers shall consist of ten inch (10) channel. Each stairway will require two (2) stringers with the stringer length to be determined by the contractor.

a) Each stringer shall have a one-fourth inch thick (1/4 in.) steel tab welded to the bottom on the inside in such a manner that the tab is under the first step and is not a trip hazard.

b) Each tab shall have a nine-sixteenths inch (9/16 in.) diameter hole for bolting stringers to the foundation with one-half inch (1/2 in.) diameter bolts. A minimum of one-half inch (1/2 in.) of metal must be maintained around the hole. The tab hole alignment shall be such that it is between the bars of the first tread so that a one-half inch (1/2 in.) diameter concrete drill bit can be placed between the bars and down through the hole in the tab.

c) Each stringer shall be secured to the stairway platform frame and/or stairway platform supports by welds and/or bolts such that the stairs, when combined with the stairway platform, form a self-supporting stairway. Bolting will require two (2) seven-eighths inch (7/8 in.) diameter holes and two three-fourths inch (3/4 in.) bolts per stringer. A minimum of one-half inch (1/2 in.) of metal must be maintained around holes.

b. Treads, clips, and stringers, including but not limited to welds and bolts, shall be designed, constructed, and installed to support a moving concentrated load of at least one-thousand pounds (1,000 lbs.) [OSHA 1910.24 (c)]. Load bearing bolts shall be 10,000 PSI minimum shear bolts.

c. Stairs shall be thirty inches (30 in.) wide as measured between the inner edges of the stringers [OSHA 1910.24 (d) requires minimum 22 inch width], and have a uniform rise height, uniform tread run, and uniform tread width [OSHA 1910.24 (f) requires uniform rise height and uniform tread width].

1) Rise height shall be at least eight and three-fourths inches (8 3/4 in.) but no more than nine and one-half inches (9 1/2 in.) [OSHA 1910.24 (e), Table D 1, values of rise for angles to the horizontal of 45 degrees to approximately 50 degrees].

2) Tread run shall be at least eight inches (8 in.) but no more than eight and three-fourths inches (8 3/4 in.) [OSHA 1910.24 (e), Table D 1, values of tread run for angles to the horizontal of 45 degrees to approximately 50 degrees].

3) Tread width shall be a minimum of nine and eleven-sixteenths inches (9 11/16 in.) (i.e., eight 3/16 in. bearing bars that are 1 3/16 in. on center).

d. Stair railing shall be installed along the stairs [OSHA 1910.23 (d) (1)] on both open sides [OSHA 1910.23 (d) (1) (iii) and OSHA 1910.24 (h)] and shall consist of top railing, intermediate railing, and posts [OSHA 1910.23 (e) (2) and OSHA 1910.24 (h)] that are constructed of one and one-half inch (1 1/2 in.) diameter schedule 40 steel pipe [OSHA 1910.23 (e) (3) (ii)] that is welded together. All railing surfaces shall be smooth [OSHA 1910.23 (e) (1) requires smooth top railing].

1) Top railing shall be installed such that the height of the railing is thirty-two inches (32 in.) as measured vertically from the top surface of the front edge of a tread to the top surface of the top railing [OSHA 1910.23 (e) (2) requires 30 in. to 34 in. height for stair top railing].

2) Intermediate railing shall be installed such that the height of the railing is sixteen inches (16 in.) as measured vertically from the top surface of the front edge of a tread to the center of the intermediate railing [OSHA

1910.23 (e) (2) requires stair railing to be similar to standard railing: intermediate railing height = 1/2 top railing height].

3) Stair posts shall be installed at the beginning and end of all stair top railing and intermediate railing spans. Middle stair posts are also required every eight feet (8 ft.) along continuous top railing and intermediate railing spans [OSHA 1910.23 (e) (3) (ii)].

a) Posts at the stair entrance and middle posts shall be welded and/or bolted to the outside or top of the stringers.

b) Posts at the top of the stairs shall be welded and/or bolted to the outside or top of the stringers and/or outside of the stairway platform frame.

c) If posts are bolted instead of welded, two (2) seven-eighths inch (7/8 in.) diameter holes and two (2) three-fourths inch (3/4 in.) diameter bolts will be required to secure each post. A minimum of one-half inch (1/2 in.) of metal shall be maintained around all bolt holes.

4) Stair railing shall be designed, constructed, and installed such that all railing, including all welds used to connect top railing, intermediate railing, and posts together, and all welds and/or bolts used to secure posts to the stringers and/or stairway platform frame, has the strength to withstand a two-hundred pound (200 lb.) force applied in any direction at any point on the top railing [OSHA 1910.23 (e) (3) (iv)]. All bolts shall be 10,000 PSI minimum shear bolts.

2. Stairway platform shall consist of a frame, supports, standard railing, and a floor. Stairway platform shall have a stair entrance that is thirty inches (30 in.) wide as measured between the toeboard on either side of the entrance, and a catwalk platform entrance that is thirty-six inches (36 in.) wide as measured between the toeboard on either side of the entrance. Stairway platform shall be constructed such that someone ascending the stairs must turn left on the stairway platform to enter the catwalk platform.

a. Stairway platform frame shall be constructed of four (4) three inch by five inch by one-fourth inch thick (3 in. x 5 in. x 1/4 in. thick) steel angles that are welded or bolted together. The five inch (5 in.) leg of all the steel angles used in the construction of the frame shall be in the vertical plane.

1) The bolting together of any portion of the stairway platform frame will require two (2) seven-eighths inch (7/8 in.) diameter holes and two (2) three-fourths inch (3/4 in.) diameter bolts at each point where bolting will occur. A minimum of one-half inch (1/2 in.) of metal must be maintained around all holes.

The steel angle on the side of the stairway platform frame that will be the entrance to the catwalk platform from the stairway platform (i.e., the side that abuts the catwalk platform) shall have the five inch (5 in.) leg of the steel angle protruding downward [OSHA 1910.23 (c) (1)], and have two (2) slotted holes for bolting the stairway platform frame to the catwalk platform frame.

a) Bolt holes shall be seven-eighths inches (7/8 in.) wide, two (2 in.) long in the horizontal direction, and located in the vertical leg at opposite ends. A minimum of one-half inch (1/2 in.) of metal must be maintained around all bolt holes.

2) The steel angle on the side of the stairway platform frame that will be the entrance to the stairway platform from the stairs (i.e., the side that abuts the stairs) shall have the five inch (5 in.) leg of the steel angle protruding upward as toeboard [OSHA 1910.23 (c) (1)] with the portion of the vertical leg that spans the entrance cut down so that it matches or is no more than one-fourth inch (1/4 in.) lower than the top surface of the stairway platform floor.

3) The remaining two (2) steel angles that do not span an entrance shall have the five inch (5 in.) legs protruding upward as toeboard [OSHA 1910.23 (c) (1)].

4) Stairway platform frame, including but not limited to all welds, bolts, and materials shall be designed, constructed, and installed to support a moving concentrated load of at least one-thousand pounds (1,000 lbs.) [OSHA 1910.24 (c)]. Load bearing bolts shall be 10,000 PSI minimum shear bolts.

5) The stairway platform frame shall have four (4) nine-sixteenths inch (9/16 in.) diameter holes for bolting the stairway platform floor in place using one-half inch (1/2 in.) diameter bolts. A minimum of one-half inch (1/2 in.) of metal must be maintained around all holes.

6) The stairway platform frame shall be bolted and/or welded to the stairway platform supports. If the frame is bolted to the supports, two (2) seven-eighths inch (7/8 in.) diameter holes and two (2) three-fourths inch (3/4 in.) diameter bolts will be required near each corner of the frame for a total of eight (8) holes and eight (8) bolts. A minimum of one-half inch (1/2 in.) of metal must be maintained around the holes.

b. Four (4) stairway platform supports will be required. Supports shall be constructed of three inch by three inch by one-fourth inch thick (3 in. x 3 in. x 1/4 in. thick) steel angles that are welded or bolted to each corner of the frame. Bolting will require two (2) seven-eighths inch (7/8 in.) diameter holes and two (2) three-fourths inch (3/4 in.) diameter bolts (eight [8] total bolts and bolt holes) near the ends of the support for bolting to the frame. A minimum of one-half inch (1/2 in.) of metal must be maintained around the holes.

1) Stairway platform supports shall be sized such that the stairway platform flooring height matches the catwalk platform flooring height and the junction of the separate floors does not present a trip hazard.

2) Each stairway platform support shall have a one-fourth inch thick (1/4 in. thick) steel tab welded to the bottom such that the tab lies flat against the foundation surface and does not present a trip hazard.

a) Each tab shall have a nine-sixteenths inch (9/16 in.) diameter hole for bolting the stairway support to the foundation using one-half inch (1/2 in.) diameter bolts. A minimum of one-half inch (1/2 in.) of metal must be maintained around all tab holes.

3) Stairway platform supports may have to be notched at the catwalk platform opening and/or stair opening.

c. Stairway platform railing shall consist of top railing, intermediate railing, and posts [OSHA 1910.23 (e) (1)]. All stairway platform railing shall be constructed of one and one-half inch (1 1/2 in.) diameter schedule 40 steel pipe [OSHA 1910.23 (e) (3) (ii)] that is welded together. All railing surfaces shall be smooth [OSHA 1910.23 (e) (1) requires smooth top railing].

1) Top railing shall be installed around the perimeter of the stairway platform along the two (2) sides of the platform that do not contain an entrance to the stairs or the catwalk platform (i.e., that do not abut the stairs or catwalk platform) [OSHA 1910.23 (c) (1) and OSHA 1910.24 (h)]. Top railing shall have a vertical height of forty-two inches (42 in.) as measured from the stairway platform floor top surface to the top surface of the railing [OSHA 1910.23 (e) (1)].

2) Intermediate railing shall be installed around the perimeter of the stairway platform along the two (2) sides of the platform that do not contain an entrance to the stairs or the catwalk platform (i.e., that do not abut the stairs or catwalk platform) [OSHA 1910.23 (c) (1) and OSHA 1910.24 (h)]. Intermediate railing shall have a vertical height of twenty-one inches (21 in.) as measured from the stairway platform floor top surface to the center of the railing [OSHA 1910.23 (e) (1)].

3) Posts shall be welded or bolted to the outside of the stairway platform frame. An exception will be made to allow some of the posts to be welded or bolted to the outside or top of the stair stringers. If posts are bolted instead of welded, two (2) seven-eighths inch (7/8 in.) diameter holes and two (2) three-fourths inch (3/4 in.) diameter bolts will be required to secure each post. A minimum of one-half inch (1/2 in.) of metal shall be maintained around all bolt holes.

a) A post with a chain loop welded to it near the top will be required on each side of the entrance from the stairs to the stairway platform. Contractor shall protect the opening between the posts by providing a safety chain that spans the opening. Safety chain shall include a spring-loaded clasp on each end that can be secured to a chain loop.

(i) The post located at the top of the stairs and on the left side of the entrance for someone ascending the stairs (i.e., the entrance post at the top of the stairs that will be nearest to the AST system) shall

be considered a stair post and shall be used in conjunction with stair top railing and stair intermediate railing only.

ii) The post located at the top of the stairs and on the right side of the entrance to someone ascending the stairs (i.e., the entrance post at the top of the stairs that will be furthest from the AST system) shall be considered as both a stairway platform post and a stair post and shall be used in conjunction with stairway platform top railing, stairway platform intermediate railing, stair top railing, and stair intermediate railing.

b) A post will be required near each of the two (2) corners of the stairway platform that are furthest from the entrance of the stairs to the stairway platform (i.e., on each end of the side of the stairway platform that is opposite and parallel to the side containing the stair entrance). These posts shall be considered as stairway platform posts and shall be used in conjunction with stairway platform top railing and intermediate railing only.

4) Stairway platform railing shall be designed, constructed, and installed such that all railing, including all welds used to connect top railing, intermediate railing, and posts together, and all welds and/or bolts used to secure posts to the stringers and/ or stairway platform frame, has the strength to withstand a two-hundred pound (200 lb.) force applied in any direction at any point on the top railing [OSHA 1910.23 (e) (3) (iv)]. All bolts shall be 10,000 PSI minimum shear bolts.

d. Stairway platform floor shall consist of open steel floor grating that is constructed of carbon steel and has standard mesh (i.e., type 19W2), serrated surface, cross bars spaced two inches (2 in.) or less on center, and one and one-fourth inch (1 1/4 in.) deep by three-sixteenths inch (3/16 in.) wide bearing bars that are spaced a maximum of one and three-sixteenths inches (1 3/16 in.) on center so that the gaps between nearest edges are one inch (1 in.) or less and do not meet OSHA's definition of a floor hole [OSHA 1910.21 (a) (1)] and do not require extra protection [OSHA 1910.23 (a) (8) through (9)]. Floor shall be installed with the bearing bars perpendicular to the AST length.

1) Contractor shall use one (1) continuous piece of grating for the floor, and the grating shall be square or rectangular in shape.

a) Stairway platform floor grating shall have a one-fourth inch (1/4 in.) thick steel tab welded in each corner (four [4] tabs total) to be used for securing the floor grating to the catwalk platform frame.

(i) Each steel tab shall have a nine-sixteenths inch (9/16 in.) diameter hole in the center of the tab to be used for bolting the grating to the frame with one-half inch (1/2 in.) diameter bolts. A minimum of three-sixteenths inch (3/16 in.) of metal must be maintained around the tab hole.

b) Stairway platform floor shall be installed such that the floor height equals the catwalk platform floor height and the seam at the junction of the separate floors does not present a trip hazard.

c) Stairway platform floor shall be designed, constructed, and installed to support a moving concentrated load of at least one-thousand pounds (1,000 lb.) [OSHA 1910.24 (c)].

e. Stairway platform shall be designed, constructed, and installed such that it is square or rectangular in shape [OSHA 1910.24 (g) requires platform width to equal or exceed stair width and platform length to be at least thirty inches (30 in.)].

H. If any portion of the design of the access assembly as provided by sections 2.7 E) through 2.7 G.2.e of this Specification will result in a finished product that does not meet OSHA requirements, the contractor shall be responsible for altering and/or re-designing the access assembly so that the finished product will meet all OSHA requirements.

1. Any alteration and/or re-design of the access assembly will require prior approval from the Owner before construction of the altered or re-designed access assembly begins.

I. The intent of the access assembly is to provide safe and easy methods of filling and sticking AST systems from the top. Contractor may re-design or alter the design of the access assembly as provided by sections 2.07 E through 2.07 G.2.e of this Specification if the contractor feels that they can provide an equal or better-finished product for the same price or for a lesser price.

1. Any alteration and/or re-design of the access assembly will require prior approval from the Owner before construction of the altered or re-designed access assembly begins.

J. The access assembly shall be designed, constructed, and installed in such a manner that the entire assembly, including all joints, welds, bolts, and materials of construction that comprise the access assembly, and the connection between the access assembly and the AST, has continuity and is grounded through the grounding of the AST through the AST supports as required by Section 2.05 of this Specification.

1. If the contractor determines that the access assembly or portions of the access assembly and/or the connection of the assembly to the AST does not have the proper continuity, the contractor must ground the access assembly or portions of the access assembly separately from the AST. Separate grounding will require the following:

a. An additional grounding hole or holes similar to the holes mentioned in Section 2.01 J.2 of this Specification with the location and number of grounding holes to be determined by the contractor;

b. An extra grounding rod matching the type mentioned in Section 2.05 D.1 of this Specification;

c. An additional ten feet (10 ft.) of copper wire for each additional grounding hole required that matches the type mentioned in Section 2.05 D.2 of this Specification; and

d. A method for securing grounding wire that matches the method mentioned in Section 2.05 D.3 of this Specification.

2. If an alternate method of grounding is used, or if separate grounding will be performed, or if additional grounding is required, the contractor shall be responsible for notifying the Owner

in writing and obtaining the Owner's approval as mentioned in sections 2.05 E and 2.05 F. of this Specification.

PART 3 - DISPENSING ELEMENT

3.01 DISPENSER

A. Dispenser shall comply with OFC 1301:7 7 28, particularly FM 2805.2, F 2805.3, and FM 2805.9, and all applicable sections of the fire and mechanical code, including but not limited to the following:

1. NFPA 30A 2 4.6.2, 2 4.6.5, 4 2, 4 3, and 7 2.1; and

2. UFC 5201 and 5202.

B. Dispenser shall be constructed and/or coated to be corrosion resistant.

C. Dispenser shall be compatible for use with both diesel and gasoline.

D. Dispenser shall be a Gasboy® Model 9153K dispenser, or equivalent.

1. Dispenser shall be a single product full cabinet dispenser with a suction pump capable of pumping up to twenty-two gallons per minute (22 GPM).

2. Dispenser shall have a one (1) horsepower 60 Hz electric motor that is capable of operating at 115 VAC or 230 VAC and has a method or switch for selecting 115 VAC or 230 VAC.

3. Motor shall be explosion proof.

4. Dispenser housing shall have a durable factory finish.

5. Dispenser shall be labeled as either gasoline or diesel in the product display area. The Owner will specify type of use (gasoline or diesel) when ordering dispensing elements.

6. Dispenser shall have the following equipment and features:

a. Illuminated dial face;

b. Register capable of recording individual deliveries to 999.9 gallons and totalizer records of 999,999.9 gallons or better;

c. Meter with an accuracy flow rate of plus or minus three tenths of a percent (+ or - 0.3 %) or better;

d. A one and one-half inch (1-1/2 in.) NPT inlet and a one inch (1 in.) NPT outlet; and

e. Built-in hose retractor.

3.02 HOSE ASSEMBLY

A. Hose assembly and product dispensing shall comply with OFC 1301:7 7 28, particularly FM 2805.2, FM 2805.7, and FM 2807.5.5, and all applicable sections of the fire and mechanical code, including but not limited to the following:

1. NFPA 30A 2 4.6.2, 2 4.6.3, 4 2, 4 3, and 7 2.1; and

2. UFC 5201, 5202, and Appendix II-F (6.4).

B. Hose assembly shall be constructed and/or coated to be corrosion resistant.

C. Hose assembly shall be compatible for use with both diesel and gasoline.

D. Hose assembly shall consist of a fuel filter base, fuel filter, product hose, reconnectable hose breakaway device, swivel, and nozzle. All components of the hose assembly shall be UL-listed for the intended purposes for which they will be used.

1. Fuel filter base shall be a Cim-Tek Model 805 single aluminum adapter (1 in. NPT) or equivalent.

   a. Fuel filter base shall be installed externally and adjacent to the dispenser on the effluent side.

2. Fuel filter shall be a high-volume commercial spin-on filter (1 in. NPT) that, when used in conjunction with the Cim-Tek model 805 base or equivalent, shall be rated to provide filtration for flows of up to thirty gallons per minute (30 GPM), and is:

   a. A Cim-Tek 800 10 fuel filter or equivalent (for use with dispensing elements specified to be gasoline) that has the following;

      1) ten (10) micron nominal filtration for particulate removal.

   b. A Cim-Tek 800HS 30 Type 2 fuel filter or equivalent (for use with dispensing elements specified to be diesel fuel) that has the following;

      1) thirty (30) micron nominal filtration for particulate removal, and

      2) ability to absorb/eliminate excess water but pass small amounts of entrained water common to diesel fuel blends.

3. Product hose shall be Goodyear Flexsteel hardwall hose or equivalent.

   a. Product hose shall be of hardwall construction and shall be

      1) black in color,

      2) one inch (1 in.) inner diameter by one and one-half inch (1 1/2 in.) outer diameter, and

      3) fourteen feet (14 ft.) in length.

   b. Product hose shall be installed on the effluent side of the filter base.

   c. Hose retractor that is built-in to the dispenser shall be attached to the product hose at a distance of seven feet (7 ft.) out measured from the outer wall of the dispenser on the effluent side.

4. Reconnectable hose breakaway device shall be a Husky model 2276 Safe-T-Break or equivalent.

   a. Reconnectable hose breakaway device shall have a one inch (1 in.) diameter flow through and must be capable of the following:

      1) stopping the flow of fuel on both sides of the separation,

      2) preventing “line shock” nuisance separations,

      3) achieving proper separation from a two-hundred pound (200 lb.) to three-hundred pound (300 lb.) pull force, and

      4) retaining UL-listing after separation and reconnection.

b. Reconnectable hose breakaway device shall be installed on the effluent end of the product hose and may require a whip hose in addition to the fourteen feet (14 ft.) of product hose. If a whip hose is necessary, the whip hose shall be black in color, be compatible and UL-listed for the intended purpose, have hardwall construction, have a length of one foot (1 ft.) or less, and have an inner diameter of one inch (1 in.).

5. Swivel shall be a Husky model 0087 swivel or equivalent.

a. Swivel shall have

1) multi-plane swivel ability, and

2) one inch (1 in.) inlet and one inch (1 in.) outlet.

6. Fuel dispensing nozzle shall:

a. Be a Husky 1 + VIII high volume automatic shut-off nozzle or equivalent (for use with dispensing elements specified to be diesel fuel) that has the following:

1) Hold-open clip;

2) Automatic shut-off if and/or when

a) gas tank is full,

b) nozzle falls from fill tank,

c) nozzle is raised above horizontal;

3) One-inch (1 in.) inlet size;

4) Diesel spout;

5) Splash guard; and

6) Nozzle guard.

3.03 PIPING ASSEMBLY

A. Piping assembly shall comply with OFC 1301:7 7 28, particularly FM 2801.5, F 2803.5.1, FM 2803.10, FM 2805.2, FM 2805.9, and FM 2807.5.6, and all applicable sections of the fire and mechanical code, including but not limited to the following:

1. NFPA 30A 2 4.6, 3 1, 3 3, 3 7, and 4 3.6;

2. NFPA 30 2 3, 3 3, 3 4, 3 5, 3 6, and 3 8; and

3. UFC 5201, 5202, and Appendix II-F (6.4).

B. Piping assembly shall be constructed and/or coated to be corrosion resistant.

C. Piping assembly shall be compatible for use with both diesel and gasoline.

D. Piping assembly shall consist of product piping, ball valves (2), external fire valve, solenoid valve, pressure regulation valve (with built in shear nipple), and a flex connector. All components of the piping assembly shall be UL-listed for the intended purposes for which they will be used. Piping,

fittings, couplings, bushings, valves, and other piping components that will routinely come into contact with fuel shall NOT be constructed of galvanized material.

1. Piping shall be threaded schedule 40 piping with compatible 150# nodular iron or steel fittings, couplings, and bushings in one and one-half inch (1-1/2 in.) diameter.

    a. Exposed piping shall be painted white using Madison Chemical Industries Acrylathane 85, or equivalent.

    b. Suction piping inside the tank shall be one and one-half inch (1-1/2 in.) in diameter and shall terminate at a distance of four inches (4 in.) above the bottom of the primary tank or compartment. Product piping outside the tank to the ball valve shall be one and one-half inch (1-1/2 in.) in diameter. Product piping after the ball valve effluent shall be one and one-half inches (1 1/2 in.) in diameter.

    c. Piping running parallel to the tank end bulkhead (i.e., vertical piping) shall be supported by being secured with clamps to brackets or shelves on the AST at the top and bottom of the bulkhead.

    d. The following minimum clear distances shall be maintained around the product piping for maintenance and inspection purposes, but shall not be exceeded so as to provide protection against possible step-on:

        1) one inch (1 in.) between the AST bulkhead and vertical piping,

        2) three inches (3 in.) between the ground and horizontal piping,

        3) one-half inch (1/2 in.) around the piping as it enters the dispenser pedestal required by Section 1.07 A.4 and outlined in Section 3.04 of this Specification, and

        4) three inches (3 in.) between vertical piping and the closest wall of the dispenser pedestal box (i.e., lid overhangs box by 2 in. to provide step-on protection).

2. Ball valve shall be designed specifically for use with aboveground piping and shall be a Morrison Brothers 691 Full Port 1-1/2 in. ball valve or equivalent.

    a. Ball valve shall have the following:

        1) Steel, nodular iron, or brass material of construction,

        2) threaded connections,

        3) locking capability, and

        4) thermal expansion relief capability when valve is closed.

    b. (1) Ball valve shall be installed so that it is located within one foot (1 ft.) or less of suction outlet.

    c. (2) Ball valve shall be installed on the product piping just prior to the pipe entering the dispenser pedestal.

3. External fire valve shall be designed specifically for use with aboveground piping and shall be a Morrison Brothers 346 series 1 1/2 in. external emergency valve or equivalent.

    a. External fire valve shall have the following:

1) steel or nodular iron material of construction, and

2) threaded or flanged connections.

b. External fire valve must be located in the product piping within two feet (2 ft.) of the AST shell. The solenoid valve outlined in Section 3.03 D4 of this Specification shall be located in the piping between the pump outlet and the external fire valve.

4. Solenoid valve shall be a Morrison Brothers 710 series Solenoid Valve or equivalent.

a. Solenoid valve inlet and outlet shall each be one and one-half inches (1 1/2 in.) in diameter.

b. Solenoid valve shall be installed in the product piping following the external fire valve at the top of the tank.

c. Solenoid operates at 120 volts.

d. Solenoid must have a 100 mesh screen on the inlet side.

e. Solenoid valve must be mounted with the solenoid vertical or upright.

5. Flex connector shall be a Hose Master Fire-Shield FSSSE or FSS2WE, or equivalent.

a. Flex connector shall have the following:

1) one and one-half inch (1 1/2 in.) diameter,

2) twelve inch (12 in.) maximum length,

b. Flex connector shall be used to connect the rigid piping to the pressure regulation valve (with built in shear nipple).

c. The flex connector installation shall be such that the flex connector is completely contained within the dispenser pedestal box and does not come in contact with the floor of the dispenser pedestal box.

6. Pressure Regulation Valve shall be an EBW Model 664 Pressure Regulator Valve or equivalent.

1) The shear groove of the pressure regulator valve shall be flush or nearly flush with the bottom of the plate cover portion of the dispenser pedestal that is required by Section 1.07 A.4 and outlined in Section 3.04 of this Specification and/or in accordance with Manufacturer's specifications.

2) The portion of the pressure regulator valve below the shear groove shall be securely fastened to the box portion of the dispenser pedestal.

3) The pressure regulator valve body shall have sufficient clearance for moving parts, normal operation, inspection, maintenance, and testing.

4) The three-eighths inch (3/8 in.) pressure regulator return line shall be installed from the pressure regulator valve to a termination point prior to the solenoid valve and again before the ball valve at the top of the tank at the suction tube connection.

7. Expansion Relief Valve shall be a Morrison Brothers 0200AV ½-inch Expansion Relief Valve (50 psi setting) or equivalent.

3.04 DISPENSER PEDESTAL

A. Dispenser pedestal shall allow dispensing element to comply with OFC 1301:7 7 28, particularly FM 2805.9, and all applicable sections of the fire and mechanical code, which includes but is not limited to NFPA 30A 4 2.5.

B. Dispenser pedestal (excluding bolts, nuts, and washers) shall be constructed of carbon steel that is painted to be corrosion resistant. Galvanized steel will not be accepted because zinc oxides and zinc hydroxides in the coating react with the paint and cause delamination.

1. All surfaces of the pedestal that are exposed after construction of the pedestal is complete, including the pedestal interior as well as exterior, and all surfaces exposed by drilling holes, shall be painted black using Madison Chemical Industries Acrylathane 85, or equivalent.

C. All bolts, nuts, and washers used in conjunction with the pedestal shall be constructed and/or factory coated to be corrosion resistant (i.e., the bolts, nuts, and washers must be galvanized, or constructed of stainless steel, or have some type of equivalent method of corrosion resistance applied at the factory).

D. Dispenser pedestal shall be a Morrison Brothers 434 Pedestal (compatible with the Gasboy / Atlas Dispenser) or an approved equal which works in conjunction with provided dispenser.

1. 34”L x 21”W x 16”H base that is 12 gauge steel, powder coated.

E. The intent of the dispenser pedestal is to allow all piping to remain aboveground while providing methods for items listed below. Contractor may alter the dispenser pedestal design if the alternative design incorporates the methods as listed below. Construction of an alternative design will require the Owner’s approval.

1. A method for spill containment under the dispenser. Box shall be utilized as a sump that has an approximate spill containment capacity of five (5) gallons below the piping entrance hole.

2. A method for securely bolting the dispenser in place. Dispenser shall securely bolt to the plate cover, which shall securely bolt to the box which shall securely bolt to the concrete slab or foundation under the dispenser pedestal.

3. A method for securely fastening the pressure regulator valve in place. The pressure regulator valve shall be securely fastened to a stabilizer bar that is firmly bolted in place.

4. A method for venting the dispenser pedestal that minimizes rainwater accumulation inside the dispenser pedestal. The piping entrance hole shall provide open venting of the box. The plate cover shall prevent rainwater from entering through the top of the box and the overhang of the plate cover shall impede rainwater from entering through the piping entrance hole.

5. A method for minimizing corrosion by limiting dispenser pedestal contact with the ground. The dispenser pedestal shall have one-half inch (1/2 in.) legs to minimize corrosion due to contact with the ground.

PART 4 LABELING, MARKINGS, IDENTIFICATION

4.01 UNDERWRITERS’ LABORATORY REQUIREMENTS

A. All aboveground storage tanks shall have labeling, markings, and/or identification regarding the Underwriters' Laboratory Listing (UL 2085, "Insulated Secondary Containment Aboveground Tank for Flammable Liquids," or, if UL 2085 changes, the subsequent UL listing required by the Steel Tank Institute for Fireguard ASTs). UL Listing shall be displayed on the fill end of single use ASTs and the diesel-dispensing end of dual use ASTs.

4.02 STEEL TANK INSTITUTE REQUIREMENTS

A. All aboveground storage tanks shall have labeling, markings, and/or identification required by Section 9.0 of Steel Tank Institute Publication #F941 (Jan., 1997 edition), "Standard for Thermally Insulated Aboveground Storage Tanks", which includes but is not limited to:

1. The serial numbered, brass label issued by the Steel Tank Institute;

2. Vinyl Fireguard label which shall be displayed in the center of all four (4) sides of the AST;

3. Steelmark label which shall be displayed above the left hand corner of each Fireguard label;

4. The required venting capacities which includes

a. the required venting capacity for the secondary tank (annulus space),

b. the required venting capacity for the primary tank of single use ASTs, and

c. the required venting capacities for each compartment of dual use ASTs;

5. The weight of the AST; and

6. Other appropriate warning labels include but are not limited to statements such as

a. "Tank cannot be reused after fire."

b. "Each compartment requires overfill prevention and an anti-siphon device."

B. The brass label with the serial number, the required venting capacities, the AST weight, and other appropriate warning labels required by the Steel Tank Institute shall be displayed on the diesel-dispensing end of the AST.

4.03 DIMENSIONS AND CAPACITY INFORMATION

A. Aboveground storage tank shall have labeling, markings, and/or identification regarding AST dimensions and capacity, which shall be displayed on the diesel-dispensing end of the ASTs.

1. The AST shall have labeling, markings, and/or identification of the secondary tank length and diameter.

2. The AST shall have labeling, markings, and/or identification of the length, diameter, and capacity of each compartment.

4.04 DUAL BULKHEAD SPLIT IDENTIFICATION

A. The aboveground storage tank shall have a one inch thick (1 in. thick) black stripe on the circumference of the AST exterior to identify the AST split that creates the two separate compartments. The stripe shall be such that it is centered between the two (2) bulkheads used to split the primary tank into compartments.

1. The stripe must be a durable decal or must be painted on. If paint is used, the paint shall be Madison Chemical Industries Acrylathane 85, or equivalent.

4.05 PRODUCT IDENTIFICATION

A. Aboveground storage tank shall have four inch (4 in.) upper case block lettering displayed on the exterior indicating whether the intended product or products are GASOLINE or DIESEL.

1. The AST shall have GASOLINE displayed on the three (3) exposed sides of the smaller compartment and DIESEL displayed on the three (3) exposed sides of the larger compartment.

2. GASOLINE lettering shall be black and DIESEL lettering shall be green. All lettering shall be at least three-fourths of an inch (3/4 in.) thick.

a. The intended product for an AST or compartment must be identified on the AST or compartment by being painted on or through the use of a durable, rectangular, one-piece decal that has a white background for the lettering. Painting will require that the paint be Madison Chemical Industries Acrylathane 85, or equivalent.

B. Fill/spill containment boxes shall have one inch (1 in.) upper case block lettering displayed on the exterior of the lid indicating the intended product corresponding to that fill followed by the word FILL (i.e., GASOLINE FILL or DIESEL).

1. GASOLINE FILL lettering shall be black. DIESEL FILL lettering shall be green. All lettering shall be at least one-fourth inch (1/4 in.) thick.

a. Fill/spill containment box markings must be painted on or be a durable, rectangular, one-piece decal with a white background. Painting will require the paint be Madison Chemical Industries Acrylathane 85, or equivalent.

C. Every dispenser shall have a sticker with one inch (1 in.) block lettering or larger affixed in the product display area indicating whether the intended product is GASOLINE or DIESEL.

1. Sticker shall be a durable, one-piece, rectangular decal that has black lettering on a white background. Lettering shall be at least one-fourth inch (1/4 in.) thick.

4.06 HAZARD IDENTIFICATION

A. Aboveground storage tank shall have four inch (4 in.) upper case block lettering displayed on the exterior indicating whether the intended product or products are FLAMMABLE or COMBUSTIBLE and indicating NO SMOKING.

1. The smaller compartment (gasoline) of the AST shall have FLAMMABLE with NO SMOKING underneath displayed on the three (3) exposed sides of the compartment near but below the intended product identification required by Section 4.05 A.1 of this Specification (directly below GASOLINE).

2. The larger compartment (diesel) of the AST shall have COMBUSTIBLE with NO SMOKING underneath displayed on the three (3) exposed sides of the compartment near but below the intended product identification required by Section 4.05 A.1 of this Specification (directly below DIESEL).

3. FLAMMABLE or COMBUSTIBLE and NO SMOKING lettering shall be red. All lettering shall be at least three-fourths of an inch (3/4 in.) thick.

a. FLAMMABLE or COMBUSTIBLE and NO SMOKING lettering must be painted on or be durable, rectangular, one-piece decals with white backgrounds. Painting will require the paint to be Madison Chemical Industries Acrylathane 85, or equivalent.

B. Aboveground storage tank shall have placarding that indicates the product code and flammable hazard rating of the intended product or products.

1. The smaller compartment of the AST shall have the placarding displayed on the three (3) exposed sides of the smaller compartment near the location of the intended product identification required by Section 4.05 A.1 of this Specification.

2. The larger compartment of the AST shall have the placarding displayed on the three (3) exposed sides of the larger compartment near the location of the intended product identification required by Section 4.05 A.1 of this Specification.

3. The product codes and flammable hazard ratings for the placarding shall be as follows:

a. For gasoline placarding, the product code shall be 1203 and the flammable hazard rating shall be 3.

b. For diesel, the product code shall be 1993 and the flammable hazard rating shall be 2.

4. Product code/flammable hazard rating placarding shall consist of diamond shaped decals with uniform sides that are at least ten inches (10 in.) in length (i.e., a 10 in. x 10 in. square or larger that is rotated to be a diamond). Each placarding decal shall have the following:

a. A red background with one-eighth inch (1/8 in.) thick white trim lines parallel to and approximately one-half inch (1/2 in.) in from each side of the diamond;

b. A white rectangle centered within the diamond that has a height of at least four inches (4 in.) and a width of at least seven and one-half inches (7 1/2 in.);

c. The symbol for flammable/combustible liquids (i.e., a flame) located near the top point of the diamond;

d. Black numbering for the product code that is centered within the white rectangle and has a minimum text height of three and one-half inches (3 1/2 in.), a minimum text width of one and three-eighths inches (1 3/8 in.), and a minimum text line thickness of three-eighths of an inch (3/8 in.); and

e. White numbering for the flammable hazard rating that is located near the bottom point of the diamond and has a minimum text height of two inches (2 in.), a minimum text width of one inch (1 in.), and a minimum text line thickness of three-eighths of an inch (3/8 in.).

C. Aboveground storage tanks shall display the Hazardous Materials Identification System (HMIS) on the exterior of the AST. The HMIS shall be in accordance with NFPA 704.

1. The HMIS shall have health, flammability, and instability hazard ratings located in a square-on-point field such that the entire field is diamond shaped with uniform fifteen inch (15 in.) sides (i.e., a 15 in. x 15 in. square that is rotated to have a diamond shape) and each individual hazard rating field is diamond shaped with uniform seven and one-half inch (7 1/2 in.) sides (i.e., four 7.5 in. x 7.5 in. squares that are rotated to have diamond shapes and share a common point where the intersection of one corner from each hazard rating field occurs).

a. The health hazard rating field shall be in the 9:00 position and shall have a blue background.

b. The flammability hazard rating field shall be in the 12:00 position and shall have a red background.

c. The instability hazard rating field shall be in the 3:00 position and shall have a yellow background.

d. The unused hazard field shall be in the 6:00 position and shall have a white background.

2. The AST shall have the HMIS displayed on all four (4) sides of the AST.

3. HMIS hazard rating lettering shall be black in color.

a. Letter height shall be six inches (6 in.).

b. Line thickness of the lettering shall be fifteen-sixteenths of an inch (15/16 in.).

c. Letter width shall be four and one-fifth inches (4 1/5 in.) for numerals 0, 2, 3, and 4. Letter width for the numeral 1 shall be the same as the line thickness.

4. The HMIS must be identified on the AST by being painted on or by using an HMIS decal kit. Painting will require the paint to be Madison Chemical Industries Acrylathane 85, or equivalent.

D. Every dispenser shall have stickers with one inch (1 in.) block lettering or larger affixed to the front panel instructing users to STOP ENGINE and indicating NO SMOKING.

1. Stickers shall be durable, one-piece, rectangular decals that have black lettering on white backgrounds. Lettering shall be at least one-fourth inch (1/4 in.) thick.

4.07 VENT IDENTIFICATION

A. Aboveground storage tanks shall have one inch (1 in.) upper case block lettering displayed on top of the AST near each vent opening that differentiates between the different vents (i.e., pressure vacuum vents, primary tank emergency vents, compartment tank emergency vents, and interstitial emergency vents).

1. Lettering shall be at least one-fourth inch (1/4 in.) thick and black in color, and must be painted on or be a durable sticker.

a. Painting will require the paint to be Madison Chemical Industries Acrylathane 85, or equivalent.

b. Stickers shall be durable, one-piece, rectangular decals that have white backgrounds.

2. Vents and vent openings shall be differentiated as follows:

a. The AST shall have lettering on top of the AST near the pressure/vacuum vent opening that indicates “PRESSURE/ VACUUM VENT.”

b. The AST shall have lettering on top of the AST near the compartment tank emergency vent opening that indicates “COMPARTMENT TANK EMERGENCY VENT.”

c. The AST shall have lettering on top of the AST near the interstitial emergency vent that indicates “INTERSTITIAL EMERGENCY VENT.”

PART 5 MISCELLANEOUS

5.01 EQUIPMENT NOTEBOOK

A. Contractor shall be responsible for providing the Owner with an Equipment Notebook.

1. The Equipment Notebook shall contain the following:

a. Detailed as-built diagrams of the tank and entire AST system including dimensions and labeling of tank openings;

b. A listing and inventory of all equipment and products that constitute the AST system including information on products and equipment used such as the name of the Manufacturer, model number, size, and any other pertinent or relevant information;

c. Catalogue cut-sheets and/or Manufacturer's literature regarding all equipment and products that constitute the AST system; and

d. A list with instructions and diagrams that pertains to any anchoring, hook-ups, connections, procedures.

2. Contractor shall include the quantity Equipment Notebooks as indicated in Division 1. The Equipment Notebook shall have labeling on the front cover (i.e., a Title) that indicates the size and use of the AST system, and the name and address of the location where the AST system is delivered.

3. After award but before construction begins, awarded contractors must supply the Owner with preliminary copies of the Equipment Notebook for review by the Owner. In lieu of providing as-built information as required by sections 5.01 A.1.a through 5.01 A.1.d of this Specification, the contractor shall provide proposed information. The Owner will not submit orders to a particular contractor for AST systems until all preliminary Equipment Notebooks have been received from that contractor and reviewed and accepted by the Owner.

a. Awarded contractors shall supply the Owner with one (1) copy of the preliminary Equipment Notebook for each size and type of AST system awarded to that contractor.

b. If information contained in the preliminary Equipment Notebook as required by Section 5.01 A.3 for a particular size and type of AST system is different than the information contained in the as-built Equipment Notebook as required by Section 5.01 A.2 of this Specification for the same size and type of AST system, the contractor shall be responsible for providing a copy of the as-built Equipment Notebook as indicated in Division 1.

5.02 STAINING/BLEEDING

A. Contractor shall be responsible for minimizing rust staining and bleeding.

1. Contractor shall paint and/or coat all exposed surfaces of the piping, dispenser pedestal, AST, and items welded to the exterior of the AST as required by this Specification, and hot-dip galvanize the access assembly as required by this Specification.

2. Contractor shall paint, coat, and/or hot-dip galvanize all surfaces exposed from drilling holes as required by this Specification.

3. Contractor shall paint and/or coat all exposed surfaces of any AST equipment or accessory that does not come painted or coated from the factory. When available, the contractor shall provide factory painted or factory coated equipment and accessories.

4. Contractor shall paint and/or coat all male product piping threads and all pipe nipple threads that are external to the AST. When the contractor installs a threaded piece of pipe, equipment, or accessory, and then backs off the threads, the contractor shall be responsible for touching-up the threads where the backing off occurred.

5. Contractor shall caulk around the brass label on the AST.

6. Contractor shall use corrosion resistant nuts, bolts, and washers in conjunction with the access assembly and dispenser pedestal as required throughout this Specification.

7. Contractor shall use corrosion resistant nuts, bolts, washers, fasteners, etc., in conjunction with the AST system whenever possible.

B. Madison coatings should not be applied to hot-dip galvanized items because delamination may occur {CorroNews}.

C. Galvanized items should not be used if the galvanized coating on the item will be exposed to petroleum product because diesel fuel is not compatible with galvanized materials {PEI/RP200 96}. Because of diesel incompatibility, and because of the potential of product switching by the Owner, galvanized items that will be exposed to diesel or gasoline will not be permitted.

5.03 TOUCH-UP PAINT

A. Contractor shall be responsible for providing touch-up paint.

1. Contractor shall provide one (1) quart of white and one (1) quart of black touch-up paint.

a. White touch-up paint shall be Madison Chemical Industries Acrylathane 85, or equivalent, and shall be the same as the paint specified in Section 2.01 A.7 of this Specification that is used to paint the steel outer wall of the AST.

b. Black touch-up paint shall be Madison Chemical Industries Acrylathane 85, or equivalent, and shall be the same as the paint specified in Section 3.04 B.1 of this Specification that is used to paint the dispenser pedestal.

5.04 TIGHTNESS TESTING

A. Contractor shall be responsible for designating a testing company, for having each AST system purchased by the Owner from that contractor tested for tightness on site after delivery but before system start-up, and for the testing company's actions.

1. Contractor shall make provisions and/or modifications to the AST system during construction to allow for testing to be performed.

2. With regards to tightness testing, the contractor shall assume that

a. The primary tank, interstice, and product piping from the shear valve to the pump, including the flex connector, will require testing, and that these components can be tested concurrently and/or consecutively (i.e., in other words, the Owner will not permit piping to be tested one week and tank testing the next week, but will permit testing of an AST system to be performed concurrently and/or consecutively); and

b. The stairway is required to be secured in place and the flex connector secured in place prior to testing of the AST system.

3. Contractor shall provide the testing company with any relevant information and/or procedures necessary for the performance of the testing, and pay for testing services rendered.

4. In the event that an AST system or any part of that AST system fails a tightness test, repairs shall be made and the AST system shall be re-tested.

5. Contractor shall be responsible for making the arrangements regarding test date and time with the contractor's designated testing company, and for arranging to have the proper regulatory officials present for the testing.

6. After testing is complete, the contractor shall be responsible for having the AST system restored to its original condition, and for assembling on site those items, equipment, and accessories not previously assembled as per Section 1.01 of this Specification.

   a. Testing personnel who have permission from the contractor may act on the contractor's behalf and assemble those items, equipment, and accessories on site that were not previously assembled and/or removed for testing purposes.

5.05 AST SYSTEM START-UP

A. AST system start-up shall be when the Owner receives product into the AST system and begins using that system in a manner to perform a preliminary test of the system.

1. AST system start-up shall not occur until after the following:

   a. All permitting is complete;

   b. Installation of the AST system is complete;

   c. The AST system has passed a tightness test as required by Section 5.04 of this Specification;

   d. The AST system has passed any inspections and tests required by regulatory authorities;

   e. The AST system has passed an inspection and operating test by the Owner; and

   f. The AST system has passed all inspections.

2. Contractor shall be required to attend start-up of AST system.

5.06 OWNER ACCEPTANCE OF THE AST SYSTEM

A. The AST system shall be considered "accepted" by the Owner when five (5) working days have elapsed after the date AST system start-up as required by Section 5.05 of this Specification has occurred unless the contractor is informed otherwise by the Owner within those five (5) days.

1. If the AST system is deemed by the Owner to be flawed or operating improperly, use of that AST system will be halted until proper actions have been taken.

   a. If the contractor is determined not to be at fault in any way for the flaws or improper operation, the Owner acceptance of the AST system will occur when the five (5) working day trial period has elapsed after AST system start-up has occurred.

   b. If the contractor is determined to be at fault in any way for the flaws or improper operation of the AST system, the Owner acceptance of the system will not occur until

      1) The proper actions have been taken;

1) AST system start-up is repeated, if start-up is deemed necessary by the Owner; and

2) A new five (5) working day trial period has occurred.

5.07 WARRANTY

A. Contractor shall warranty all components of each AST system for a period of one (1) year from the date of Contract Completion:

B. The AST shall have the thirty- (30) year warranty that comes standard with Fireguard ASTs.

C. All factory bought equipment and accessories shall have their respective standard factory warranties.

5.08 VOLUMETRIC TANK CHART

A. Contractor shall include two (2) copies of a volumetric tank chart with each AST system.

1. The volumetric tank chart shall cross-reference product depth in feet and inches to the nearest gallon of product for the size of primary tank or compartment in question, and shall have an accuracy of five percent (5%) or better.

a. The volumetric tank chart shall give product readings starting at a depth of three inches (3 in.) from the bottom of the primary tank or compartment, and terminating at a depth of one inch (1 in.) below the top of the primary tank or compartment.

b. The volumetric tank chart shall list product gallonage conversions in one-eighth inch (1/8 in.) increments.

2. In addition to the cross-referencing table, the following items shall be included on each volumetric tank chart:

a. A statement that indicates the primary tank or compartment inner diameter, in feet and inches;

b. A statement that indicates the primary tank or compartment inner length, in feet and inches;

c. A statement that indicates the primary tank or compartment capacity, in gallons;

d. A statement that indicates the intended product to be used in conjunction with the tank or compartment;

e. A statement that indicates the product depth at which the overfill alarm is set to go off, in feet and inches;

f. A statement that indicates the product depth at which shut-off of product delivery (i.e., overfill protection) is set to occur, in feet and inches;

g. The serial number of the AST that the volumetric tank chart corresponds to;

h. The name and address of the location where the AST system is delivered; and

i. A statement that says “One-fourth inch (1/4 in.) must be subtracted from stick readings due to a quarter inch thick striker plate located under the stick port.”

3. Contractor shall be responsible for having each volumetric tank chart laminated.

4. Volumetric tank charts may be double sided.

PART 6 SUMMARY OF SPECIFIED EQUIPMENT

6.01 PROVIDE EQUIPMENT AS INDICATED BELOW OR THE ASSOCIATE ENGINEER APPROVED EQUALS.

A. Aboveground Storage Tank: Fireguard (protected, secondary containment, 2 hour fire rating, 30 year warranty).

B. Vent Assembly:

1. Normal vent: OPW 23 0033 or equivalent (2 in. atmospheric vent).
2. Emergency vent: Morrison Brothers 244I series or equivalent.
3. Interstitial emergency vent: Morrison Brothers 244 series with nipple, or equivalent.
4. Vent piping: 2 in. diameter, steel or nodular iron.

C. Fill Assembly:

1. Fill/spill containment box: hinged lid, built-in spill return device, five gal. min. capacity.
2. Fill cap: 2 in. cam lock dust cap.
3. Fill/overfill prevention valve (with fill pipe terminating within 6 in. of tank bottom and cut at the bottom a 45 degree angle): OPW 61fstop 2 in., Morrison Brothers 9095A 2 in., or Clay and Bailey F 30 2 in..

D. Gauge and Alarm Equipment:

1. Product level gauge with audible overfill alarm: Morrison Brothers 918 clock gauge with alarm unit and option #5 for float inside a dip tube/drop tube or equivalent.
2. Interstitial leak detection gauge: At-A-GLANCE leak gauge by Krueger Sentry Gauges or equivalent.
3. Primary tank leak detection gauge for interstice between dual bulkheads on a splittank: At-A-GLANCE leak gauge by Krueger Sentry Gauges or equivalent.

E. Dispenser: Gasboy® Model 9153K suction dispenser or equivalent.

1. Dispenser Pedestal: Morrison Brothers 434 Pedestal

F. Piping Assembly:

1. Product piping: Non-galvanized threaded schedule 40 piping with compatible 150# nodular iron or steel fittings, and couplings (1-1/2 in. dia. suction piping under pump that terminates 4 in. above tank bottom, 1-1/2 in. dia. product piping between suction pipe and ball valve, and 1 1/2 in. dia. product piping after ball valve).
2. Ball valve: Morrison Brothers 691 full port 1-1/2 in. ball valve (with 1-1/2 in.:2 in. bushing), or equivalent.
3. External fire valve: Morrison Brothers 346 series 1 1/2 in. external emergency valve, or equivalent.
4. Solenoid Valve: Morrison Brothers Model 710 series 1-1/2 in. or equivalent.
5. Pressure Regulator valve: EBW 664 Series Pressure Regulator Valve 1 1/2 in. diameter or equivalent.

6. Flex connector: Hose Master 1 1/2 in. Fire-Shield FSSSE or FSS2WE flex connector (12 in. length or less, installed so that the flex connector is contained within the dispenser pedestal), or equivalent.

7. Return Line: The pressure regulator return line of 3/8 in. copper tubing with compatible 150# nodular iron, steel, or brass fittings from the pressure regulator to a point prior to the solenoid valve and again at the top of the tank at the point where the suction tube inters the tank.

8. Expansion Relief Valve: Morrison Brothers 0200AV ½-inch Expansion Relief Valve or equivalent.

G. Hose Assembly:

1. Fuel filter base: Cim-Tek model 805 1 in. single aluminum adaptor or equivalent.

2. Fuel filter: Cim-Tek 800 10 fuel filter for gasoline, or equivalent, and Cim-Tek 800HS 30 Type 2 fuel filter for diesel, or equivalent.

3. Product hose: Goodyear Flexsteel hardwall hose (1 in. dia., 14 ft. length), or equivalent.

4. Reconnectable hose breakaway device: Husky model 2276 Safe-T-Break or equivalent.

5. Swivel: Husky model 0087 swivel or equivalent.

6. Fuel dispensing nozzle: Husky 1 A automatic shut-off nozzle for gasoline, or equivalent, and Husky 1 + VIII high volume automatic shut-off nozzle for diesel, or equivalent.

*TBD: Indicates ‘To Be Determined’

END OF SECTION 33 56 13

SECTION 334200 - STORMWATER CONVEYANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Corrugated-steel pipe and fittings.
   2. PVC pipe and fittings.
   3. Concrete pipe and fittings.
   4. Non-pressure transition couplings.
   5. Expansion joints and deflection fittings.
   6. Cleanouts.
   7. Drains.
   8. Encasement for piping.
   9. Manholes.
   10. Polymer-concrete, channel drainage systems.
   11. Catch basins.
   12. Stormwater inlets.
   13. Pipe outlets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

   1. Manholes: Include plans, elevations, sections, details, frames, and covers.
   2. Catch basins and stormwater inlets. Include plans, elevations, sections, details, frames, covers, and grates.

C. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.

D. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes in accordance with manufacturer's written rigging instructions.

D. Handle catch basins and stormwater inlets in accordance with manufacturer's written rigging instructions.

1.6 FIELD CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements indicated:

1. Notify Construction Manager, and Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Construction Manager's, and Owner's written permission.

PART 2 - PRODUCTS

2.1 CORRUGATED-STEEL PIPE AND FITTINGS

A. Source Limitations: Obtain corrugated-steel pipe and fittings from single manufacturer.

B. Corrugated-Steel Pipe and Fittings: ASTM A760/A760M, Type I with fittings of similar form and construction as pipe.

1. Special-Joint Bands: Corrugated steel with O-ring seals.
2. Standard-Joint Bands: Corrugated steel.
3. Coating: Aluminum or Zinc.

2.2 PVC PIPE AND FITTINGS

A. Source Limitations: Obtain PVC pipe and fittings from single manufacturer.

B. NSF Marking: Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

C. PVC Cellular-Core Piping:

1. PVC Cellular-Core Pipe and Fittings: ASTM F891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
2. Fittings: ASTM D3034, SDR 35, PVC socket-type fittings.

D. PVC Corrugated Sewer Piping:

1. Pipe: ASTM F949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM F949, PVC molded or fabricated, socket type.
3. Gaskets: ASTM F477, elastomeric seals.

E. PVC Profile Sewer Piping:

1. Pipe: ASTM F794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

F. PVC Type PSM Sewer Piping:

1. Pipe: ASTM D3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

G. PVC Gravity Sewer Piping:

1. Pipe and Fittings: ASTM F679, T-2 wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F477, elastomeric seals for gasketed joints.

2.3 CONCRETE PIPE AND FITTINGS

A. Source Limitations: Obtain concrete pipe and fittings from single manufacturer.

B. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C76.

1. Bell-and-spigot or tongue-and-groove ends and sealant joints with ASTM C990 (ASTM C990M), bitumen or butyl-rubber sealant

2.4 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Concrete Pipes: ASTM C443, rubber.
2. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
3. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:
1. Source Limitations: Obtain unshielded, flexible couplings from single manufacturer.

2. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:
1. Source Limitations: Obtain shielded, flexible couplings from single manufacturer.
2. Description: ASTM C1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:
1. Source Limitations: Obtain ring-type, flexible couplings from single manufacturer.
2. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.5 CLEANOUTS

A. PVC Cleanouts:
1. Source Limitations: Obtain PVC cleanouts from single manufacturer.
2. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.6 ENCASEMENT FOR PIPING

A. Standard: ASTM A674 or AWWA C105/A21.5.

B. Material: Linear low-density polyethylene film of 0.008-inch or cross-laminated HDPE film of 0.004-inch minimum thickness.

C. Form: Sheet or tube.

D. Color: Black or natural.

2.7 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C990 , bitumen or butyl rubber.

8. Resilient Pipe Connectors: ASTM C923, cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches
10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch- minimum width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: ASTM A536, Grade 60-40-18 ductile iron unless otherwise indicated.

2.8 CONCRETE

A. General: Cast-in-place concrete in accordance with ACI 318, ACI 350, and the following:

1. Cement: ASTM C150/C150M, Type II.
2. Fine Aggregate: ASTM C33/C33M, sand.
3. Coarse Aggregate: ASTM C33/C33M, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, Grade 60 (420 MPa) deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

   a. Invert Slope: 1 percent through manhole.

2. Benches: Concrete, sloped to drain into channel.

   a. Slope: 4 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, Grade 60 (420 MPa) deformed steel.

2.9 POLYMER-CONCRETE, CHANNEL DRAINAGE SYSTEMS

A. Narrow, Sloped-Invert, Polymer-Concrete Channel Drainage Systems
1. Source Limitations: Obtain narrow, sloped-invert channel drainage systems from single manufacturer.
2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
3. Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps.

a. Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated.
b. Include extension sections necessary for required depth.
c. Dimensions: 4-inch inside width. Include number of units required to form total lengths indicated.
d. Frame: Gray-iron or galvanized steel for grates

4. Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

a. Material: Ductile iron or Gray iron

1) Locking Mechanism: Not required.

5. Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
6. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

B. Narrow, Level-Invert, Polymer-Concrete Channel Drainage Systems
1. Source Limitations: Obtain narrow, level-invert channel drainage systems from single manufacturer.
2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
3. Channel Sections: Narrow, interlocking-joint, precast, polymer-concrete modular units with end caps.

a. Include rounded bottom, with level invert and with NPS 4 outlets in number and locations indicated.
b. Dimensions: 5- inch inside width and 9-3/4 inches deep. Include number of units required to form total lengths indicated.

1) Frame: Gray-iron or galvanized steel for grates.

4. Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

   a. Material: Ductile iron or Gray iron
   b. Locking Mechanism: Not required.

5. Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
6. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

C. Wide, Level-Invert, Polymer-Concrete Channel Drainage Systems
1. Source Limitations: Obtain wide, level-invert channel drainage systems from single manufacturer.
2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
3. Channel Sections: Wide, interlocking-joint, precast, polymer-concrete modular units with end caps.

   a. Include flat or rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.
   b. Dimensions: 8- inch inside width and 13-3/4 inches deep. Include number of units required to form total lengths indicated.

      1) Frame: Gray iron or galvanized steel for grates

4. Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

   a. Material: Ductile iron or Gray iron
   b. Locking Mechanism: Not required.

5. Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
6. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

D. Drainage Specialties: Precast, polymer-concrete units.

1. Large Catch Basins:

   a. 24-by-12-inch polymer-concrete body, with outlets in quantities and sizes indicated.
   b. Gray-iron slotted grate.
   c. Frame: Include gray-iron or steel frame for grate.

2. Small Catch Basins:

   a. 19- to 24-inch by approximately 6-inch polymer-concrete body, with outlets in quantities and sizes indicated.
   b. Gray-iron slotted grate.
   c. Frame: Include gray-iron or steel frame for grate.

3. Oil Interceptors:
   a. Refer to plumbing specifications

2.10 CATCH BASINS

A. Standard Precast Concrete Catch Basins:

1. Description: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
3. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
5. Joint Sealant: ASTM C990, bitumen or butyl rubber.
6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and grate.
8. Steps: Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 60 inches
9. Pipe Connectors: ASTM C923, resilient, of size required, for each pipe connecting to base section.

B. Frames and Grates: ASTM A536, Grade 60-40-18, ductile iron designed for A-16 (AASHTO HS20-44), structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: 24 by 24 inches minimum unless otherwise indicated.
2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

2.11 STORMWATER INLETS

A. Combination Inlets: Made with vertical curb and horizontal gutter openings, of materials and dimensions in accordance with utility standards. Include heavy-duty frames and grates.

B. Frames and Grates: Heavy duty, in accordance with utility standards.

2.12 PIPE OUTLETS

A. Head Walls: Cast-in-place reinforced concrete, with apron and tapered sides.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure drainage piping in accordance with the following:

1. Install piping pitched down in direction of flow.
2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
3. Install piping with 24 inch- minimum cover.
4. Install corrugated-steel piping in accordance with ASTM A798/A798M.
5. Install PVC cellular-core piping in accordance with ASTM D2321 and ASTM F1668.
6. Install PVC sewer piping in accordance with ASTM D2321 and ASTM F1668.
7. Install PVC profile gravity sewer piping in accordance with ASTM D2321 and ASTM F1668.
8. Install nonreinforced-concrete sewer piping in accordance with ASTM C1479 and ACPA's "Concrete Pipe Installation Manual."
9. Install reinforced-concrete sewer piping in accordance with ASTM C1479 and ACPA's "Concrete Pipe Installation Manual."

G. Install corrosion-protection piping encasement over the following underground metal piping in accordance with ASTM A674 or AWWA C105/A21.5:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless cast-iron soil pipe and fittings.
3. Ductile-iron pipe and fittings.
4. Expansion joints and deflection fittings.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping in accordance with the following:
1. Join corrugated-steel sewer piping in accordance with ASTM A798/A798M.
2. Join PVC cellular-core piping in accordance with ASTM D2321 and ASTM F891 for solvent-cemented joints.
3. Join PVC corrugated sewer piping in accordance with ASTM D2321 for elastomeric-seal joints.
4. Join PVC sewer piping in accordance with ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasketed joints.
5. Join PVC profile gravity sewer piping in accordance with ASTM D2321 for elastomeric-seal joints or ASTM F794 for gasketed joints.
6. Join nonreinforced-concrete sewer piping in accordance with ASTM C14and ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
7. Join reinforced-concrete sewer piping in accordance with ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
8. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads

B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch(es) above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants in accordance with ASTM C891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.6 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.7 STORMWATER INLET AND OUTLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.

B. Construct riprap of broken stone, as indicated.

C. Install outlets that spill onto grade, anchored with concrete, where indicated.

D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.

E. Construct energy dissipaters at outlets, as indicated.

3.8 CONCRETE PLACEMENT

A. Place cast-in-place concrete in accordance withACI 318.

3.9 CHANNEL DRAINAGE SYSTEM INSTALLATION

A. Install with top surfaces of components, except piping, flush with finished surface.

B. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.

C. Embed channel sections and drainage specialties in 4- inch- minimum concrete around bottom and sides.

D. Fasten grates to channel sections if indicated.

E. Assemble channel sections with flanged or interlocking joints.

F. Embed channel sections in 4- inch- minimum concrete around bottom and sides.

3.10 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Section 221413 "Facility Storm Drainage Piping."

B. Connect force-main piping to building's storm drainage force mains specified in Section 221413 "Facility Storm Drainage Piping." Terminate piping where indicated.

C. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi
2. Make branch connections from side into existing piping, NPS 4 to NPS 20 (Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi
3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

    a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
    b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

D. Connect to sediment interceptors specified in Section 221323 "Sanitary Waste Interceptors."

E. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.

    a. Unshielded flexible couplings for same or minor difference OD pipes.
    b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
    c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

2. Use pressure-type pipe couplings for force-main joints.

3.11 IDENTIFICATION

A. Materials and their installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.12 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems in accordance with requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test in accordance with requirements of authorities having jurisdiction, UNI-B-6, and the following:

    a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
    b. Option: Test plastic piping in accordance with ASTM F1417.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.13 CLEANING

A. Clean interior of piping of dirt and superfluous materials Flush with water.

END OF SECTION 334200

SECTION 41 23 23.13 - RECESSED VERTICAL HALF-SCISSOR VEHICLE LIFT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Recessed Vertical Half-Scissor Vehicle Lift

1.2 QUALITY ASSURANCE

A. Manufacturer qualifications: The lift company selling the product shall have ISO-9001 certification and the proof of current certification shall accompany the bid.

B. Installer qualifications: For warranty validation, installation shall be performed by qualified factory authorized and trained personnel.

C. Product Requirements:

1. Design Standards and Certification: The lift shall be certified by ETL/Intertek to the ANSI/ALI Standard for Automotive Lifts, ALCTV-current edition: Safety Requirements for Construction, Testing and Validation.
2. The drive system shall permit lifting without any pulsation, jerks, or unsteady lifting. Lifting shall be smooth. System shall comprise an electrically powered pump, flow control valves, and a fluid reservoir. An electronic/hydraulic synchronization device shall ensure smooth alignment of each lifting assembly based on variances in vehicle weight. A microprocessor shall control all lift movement for ultimate operator safety and convenience. Troubleshooting codes shall facilitate service and repair.

1.3 WARRANTY

A. Manufacturer's Warranty: Lift system shall be warranted for a minimum period of 2 years for parts and 1 year labor.

PART 2 - PRODUCT

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Stertil-Koni USA, Inc., which is located at: 200 Log Canoe Circle; Stevensville, MD 21666; Toll Free Tel: 800-336-6637; Tel: 410-643-9001; Email: request info (lifts@stertil-koni.com); Web: www.stertil-koni.com

1. Distributor in Ohio for Stertil-KONI: Heavy Lift Systems, Inc. 695 Mentor Rd. Akron, OH 44303 Tel: 330/929-2997 Email: Heavyliftsystems@yahoo.com

B. Requests for substitutions will be considered in accordance with provisions of the General Conditions and Division 01 Specifications.

1. Any substitution of the specified lift requiring modifications of foundation system detailed will be the responsibility of the contractor.
2. The contractor shall provide for any and all engineering and redesign of foundation system as a result of substitution.
3. Under no circumstances will extra payment be permitted as a result of additional work to accommodate any equipment substitution.

2.2 SKYLIFTS

A. Vertical Half-Scissors Platform Lift Model SKY-250-9 FM as manufactured by Stertil-Koni USA, Inc.

1. General Description

a. A vertical half-scissors heavy-duty platform lift to elevate large trucks, buses, and other heavy-duty vehicles for the purpose of inspection, maintenance, servicing and cleaning. Lift shall rise in a vertical fashion.
b. The lift system shall be flush mounted recessed in floor as indicated on the drawings.
c. The lift system shall be totally open floor design with no obstructions between lifting platforms and no crossbeams either in the front or the rear of the platforms.
d. Lift system shall incorporate a hydraulic driven cylinder in each half scissor.
e. The maximum lifting height of the lift system shall be programmable to the height specifications as requested by user.
f. Lift shall have a complete LED lighting system installed on the inner edge to illuminate the work area when the vehicle is raised. The LED lighting shall be 24V, and rated IP 65.
g. Lift platforms shall have a skid resistant surface finish.

2. Lifting Capacity

a. The lift shall have a minimum nominal lifting capacity of:

1) 78,000 lbs. (35,381 kg)

b. The lift system shall have two (2) jacking beams:

1) Jacking beam shall be air-hydraulic self-powered operation.
2) Jacking beam shall be Stertil- KONI Model FL 160 double telescopic piston with a total capacity of up to 35,200 lbs.
3) The jacking beam shall be designed with a flow divider valve to maintain synchronization of pistons in raising and lowering mode; maximum pressure valve shall prevent lifting of loads if loads exceed rated capacity of jack; check valves in each piston shall prevent the accident descent of load.
4) Jacking beam shall have two (2) Additional ‘V’ adapters and 8”

extension sleeves for the lifting cylinders.

3. Dimensions

   a. The lift shall have a minimum lifting height of 69 inches (1,753 mm) from floor to the top of the platforms when the lift rests on the floor and a minimum lifting height of 69 inches (1,753 mm) when the lift is flush mounted to the floor.
   b. The platform dimensions shall be available in the following length: 1) 29 ½ feet (9 m).
   c. Width of the platforms for all models shall be 30 inches (762 mm).
   d. The lowered height shall be a maximum of 16 inches (406 mm) for flush mounted.
   e. Concrete thickness shall be a minimum of 6 inches (152 mm). (Coordinate with the minimum requirements of floor.)
   f. Installation shall be accommodated by 4 simple plates with 4 bolts per plate. Total installation shall not require more than 16 bolts for anchorage to the floor.

4. Drive Mechanism

   a. The drive system shall be hydraulic and shall permit lifting without any pulsation, jerks, or unsteady lifting. Lifting shall be smooth. The hydraulic power unit shall be an electrically- powered pump, flow control valves, and a fluid reservoir.
   b. Hydraulic lifting cylinders shall be of a piston type to prevent leakage in the case of piston damage.
   c. All rotating axles shall be made of stainless steel.

5. Controls

   a. The lift operating system shall have microprocessor controls within the printed circuit board to provide various safety and operational requirements.
   b. The lift system shall have all control voltage rated to a maximum of 24 VDC.
   c. Each control box shall have as a minimum:

      1) System disconnect.
      2) "Power-on" pilot lamp.
      3) An "up" button
      4) A "down" button
      5) Lock release button
      6) Lighting switch.

   d. The lift shall operate at the following voltages: 208/230V (3 phase), 460V (3 phase), 575V (3 phase)
   e. Control panel shall be rated IP 65

6. Safety Devices

a. An independent and fail-safe mechanical safety device shall be present on each half scissor. This safety device shall be totally independent from the lifting drive system. A locking catch shall be free to engage all of the teeth of the locking strip attached to the half scissor.
b. Each lifting device shall be provided with a position measuring device identified as an inclinometer whose function it is to calculate and synchronize the height of the 4 lifting devices.
c. The lift system shall incorporate a splash proof electrical system (IP 65) so that the lift can be used in a washroom environment without damage to electrical components.
d. The lift system shall have an automatic foot-guard protection.
e. Locking mechanism shall be activated in no less than 3 inches (76 mm) of lifting height

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions. Test for proper operation, and re-test if necessary until satisfactory results are obtained.

3.4 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before substantial completion

END OF SECTION 41 23 23.13

SECTION 41 23 23.16 - MOBILE COLUMN VEHICLE LIFT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Mobile Column Vehicle Lift

1.2 QUALITY ASSURANCE

A. Manufacturer qualifications: The lift company selling the product shall have ISO-9001 certification and the proof of current certification shall accompany the bid.

B. Installer qualifications: For warranty validation, installation shall be performed by qualified factory authorized and trained personnel.

C. Product Requirements:

1. Design Standards and Certification: The lift shall be certified by ETL/Intertek to the ANSI/ALI ALCTV-current edition Standard for Automotive Lifts: Safety Requirements for Construction, Testing and Validation.
2. The drive system shall permit lifting without any pulsation, jerks, or unsteady lifting. Lifting shall be smooth. System shall comprise an electrically powered pump, flow control valves, and a fluid reservoir. An electronic/hydraulic synchronization device shall ensure smooth alignment of each lifting assembly based on variances in vehicle weight. A microprocessor shall control all lift movement for ultimate operator safety and convenience. Troubleshooting codes shall facilitate service and repair.

1.3 WARRANTY

A. Manufacturer's Warranty: Lift system shall be warranted for a minimum period of 2 years for parts and 1 year labor. Hydraulic cylinder shall have a parts only warranty of five years. Guide rollers shall have a lifetime warranty; this extended warranty covers parts only.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Stertil-Koni USA, Inc., which is located at: 200 Log Canoe Circle; Stevensville, MD 21666; Toll Free Tel: 800-336-6637; Tel: 410-643-9001; Email: request info (lifts@stertil-koni.com); Web: www.stertil-koni.com

1. Distributor in Ohio for Stertil-KONI - Heavy Lift Systems, Inc. 695 Mentor Rd.

Akron, OH 44303 Tel: 330/929-2997 Email: Heavyliftsystems@yahoo.com

B. Requests for substitutions will be considered in accordance with provisions of the General Conditions and the Division 01 Specifications.

1. Any substitution of the specified lift requiring modifications of foundation system detailed will be the responsibility of the contractor.
2. The contractor shall provide for any and all engineering and redesign of foundation system as a result of substitution.
3. Under no circumstances will extra payment be permitted as a result of additional work to accommodate any equipment substitution.

2.2 MOBILE COLUMN VEHICLE LIFTS

A. Mobile Column Lifts Model ST-1085-FWA as manufactured by Stertil-Koni USA, Inc.

1. General Description:

a. A lifting system or set (consisting of up to 8 columns) for vehicles shall be composed of interchangeable columns. The size of the set shall be able to be configured by the operator at time of set up without the need to modify the operating system. It shall be possible to operate up to 480 columns within any facility. With a set of up to 8 columns it shall be possible to operate any single column, a pair of columns, or all columns together, at the same time, without the activation of switches. Each column shall contain its own power supply which consists of two deep cycle (group 31) 12 VDC batteries combined to provide a stable 24 VDC.

1) A set shall consist of a total of four (4) columns, unless noted otherwise by the Owner.

b. The main power shall be fused between the primary power switch and the motor/control circuits to protect against overload.
c. When fully charged, the on board battery power system shall be capable of 20 lifting/lowering cycles at full capacity.
d. The 24 VDC on board power supply shall incorporate a built in recharging system with a pictograph on the display so the operator can visually verify charging status.

1) The recharging system shall be a built in 110 VAC battery charger with indicator lamps. The charger indicator lamp shall be visible through a sight glass mounted in the control cabinet. The indicator lamp shall be illuminated steady red when the system is recharging, green when batteries have achieved a full recharge, and flashing green when the charger is providing a trickle charge.

e. The various functions of the mobile lifting system shall be initiated from the control panels on the columns.
f. The base frame of the lifting column shall be of a rectangular design. The contact pattern to the foundation under the column shall be triangular in

design to ensure uniform contact with the lifting foundation.

2. Lifting Capacity:

   a. Each individual column shall have a nominal rated capacity of 18,500 lbs. (8,500 kg).

3. Dimensions:

   a. The achieved lifting height of the column shall be no less than 73 inches (1,854 mm) when measured from the foundation on which the column rests to the top of the lifting fork.
   b. Column height shall not be greater than 97 inches (2,464 mm) when fully lowered and 143.5 inches (3,645 mm) when the carriage has achieved maximum height.

4. Tire Size:

   a. Wheel contact forks shall be adjustable by hand and freely accept tires with rim diameters between R10 and R22.5. The adjustable forks shall incorporate a mechanical locking device to ensure the fork cannot relocate/adjust during use

5. Pallet Jack Mechanism:

   a. The pallet jack mechanism shall have a gas shock incorporated into its design which shall serve two purposes. The primary purpose of the pallet jack gas shock shall be to serve as a safety mechanism to ensure that the mobile column is not lifting while the pallet jack is extended. If the operator fails to lower the pallet jack after column positioning, as soon as the column experiences load during a lifting cycle, the gas shock will retract to lower the column to its foundation for stable lifting. The second purpose of the pallet jack gas shock shall be to dampen the impact of floor imperfections experienced while the column is relocated.

6. Wheels:

   a. The column shall be fitted with fixed front roller wheels fabricated from oil impregnated nylon so as to be non-destructive to the foundation on which the column rests.
   b. Floor pressure at the front roller wheel location shall be no greater than 7,000 psi (48,263 kPa).

7. Mechanism:

   a. The drive system shall be hydraulic and shall permit lifting without any pulsation, jerks, or unsteady lifting. Lifting shall be smooth. The hydraulic power unit shall be an electrically-powered pump, flow control valves, and a fluid reservoir.
   b. Lifting carriage shall ride on durable oil filled nylon guide rollers. Guide rollers shall require no lubrication and no maintenance.

c. Each hydraulic cylinder shall be equipped with a hose burst check valve to prevent decent in the event of a major fluid leak.

8. Controls:

a. The various functions of the mobile lifting system shall be initiated from the control panels on the columns.
b. Each control box shall have as a minimum:

1) Exterior:

a) An "up" button.
b) A "down" button.
c) A “lock release” button.
d) A “slow (turtle)” initiate button for slowed lowering.
e) A “select” button to initialize start up and column selection.
f) Lock to prevent unauthorized entry into box.
g) LEDs to illustrate single, all, or pair operation as well as fault condition.

2) Interior:

a) PCB-printed circuit board.
b) Motor relays.
c) Reserve fuses.

c. Each column shall include an LCD screen on the outside of the column, and shall indicate to the operator:

1) Actual number of columns in set (set size). This numeric indicator shall immediately inform the operator of number columns currently included in the set.
2) Actual number of that particular column in the set of columns.
3) Actual lifting height.
4) Action in process (lifting/lowering)
5) Battery condition.
6) Hours in service of that particular column, to ensure proper maintenance is completed in a timely manner.
7) Control system shall include 42 fault codes to facilitate trouble-shooting.

d. The LCD screen shall allow the operator to view through button manipulation:

1) Initiation of multilingual operation: 8 different languages including English, French and Spanish.
2) Initiation of height restricted operation.
3) Initiation of lifting with the lock released for reduced noise output. The column shall allow the operator to initiate the retraction of the locking pawl during lifting if the operator finds the noise generated by the locking pawl to be undesirable.

4) Initiation of crush limitation (block lowering below 12 inches (305 mm) so that the columns will not lower when a remote controller is installed to prevent injury by lift.

e. The control panel of each column shall be fitted with a button that displays a turtle. The function of the turtle button shall be so that the operator can initialize the system to lower at a reduced speed to aid in the placement of support stands and the installation of under vehicle components.
f. All control panels have automatic synchronization through the full stoke of the hydraulic cylinder with a maximum tolerance of 2 inches (50 mm). Control system will actively control hydraulic correction to maintain level synchronization, unless a column deviates more than 2.4 inches (60 mm) inches from any other column, at which point all motion halts.
g. Each column shall be fitted with an individual analog height measuring device. This height measuring device shall ensure that the height of each column in the set remains synchronized at the height initiated by the operator. The height measuring device shall also allow, through single operation, that the operator can raise or lower any column to alternate heights within the tolerances set by the ALI (Automotive Lift Institute) in its manual Lifting It Right.
h. The wireless communication system shall utilize Zigbee technology and be properly shielded from external interference in the workshop.
i. The mobile column lift battery charger shall operate at the following voltages: 110VAC.
j. Control panel shall be rated IP 65.

9. Safety Devices:

a. An independent and fail-safe mechanical locking system shall be present on each column. This safety device shall be totally independent from the lifting drive system.
b. Increments on lifting carriage locking profile shall not be greater than 1.375 inches (35 mm) and the first locking position shall engage after no more than 5.0 inches (120 mm) of lifting.
c. A locking “pawl and ratchet” system shall be used to insure proper and automatic locking at any height and at all times. The locking notches shall be integrated into the lifting carriage. The locking pawl shall be mounted to the inside of the column and function as a wedge between the column and the lifting carriage. The mechanical safety lock shall be automatically engaged at all times when the lift is not operating.

B. Support Stands

1. Stertil-KONI Model SKMH 3659-12 Support Stands; 12 ton capacity; ALI/ETL Certified; w/handle & wheels; spring loaded, pin stop w/36"-58" fine adjustment; 2 heads.

a. Provide a total of four (4) support stands, unless noted otherwise by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

1. The slope of the finished floor surface should not exceed 2.5%.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions. Test for proper operation, and re-test if necessary until satisfactory results are obtained.

3.4 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before substantial completion.

END OF SECTION 41 23 23.16