BID DOCUMENTS
VOLUME 2

Architect's Certification: The undersigned certifies that, to the best of his or her knowledge, information and belief, the plans and specifications are in accordance with the applicable requirements of the New York State Uniform Fire Prevention and Building Code, the State Energy Conservation Construction Code and the Manual of Planning Standards of the Education Department and that the work for this project will involve known or suspected ACBM, and will be done in accordance with Industrial Code Rule #56.
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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 materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
5. Plumbing demolition.
6. Equipment installation requirements common to equipment sections.
7. Painting and finishing.
8. Concrete bases.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

D. The following are industry abbreviations for plastic materials:

2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

E. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.
1.4 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

D. ICC Plumbing Code and applicable portions of the New York State Uniform Code supplement.

E. State Education Department Planning Standards.

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.

C. Do not store any materials outdoors. Provide protected offsite storage or on site storage containers.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. 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 thickness or specific material is 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.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
G. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Available Manufacturers:
   b. Dresser Industries, Inc.; DMD Div.
   c. JCM Industries.
   d. Smith-Blair, Inc.

2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: 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.

1. Available Manufacturers:
   a. Eslon Thermoplastics.
   b. Approved Equal.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Available Manufacturers:
   a. Thompson Plastics, Inc.
   b. Approved Equal.

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

1. Available Manufacturers:
   a. NIBCO INC.
   b. NIBCO, Inc.; Chemtrol Div.
   c. Approved Equal.
E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Available Manufacturers:
   b. Ferneco, Inc.
   d. Plastic Oddities, Inc.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Available Manufacturers:
   a. Capitol Manufacturing Co.
   b. Central Plastics Company.
   e. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Available Manufacturers:
   a. Capitol Manufacturing Co.
   b. Central Plastics Company.
   c. Epco Sales, Inc.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Available Manufacturers:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.
2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Available Manufacturers:
   a. Calpico, Inc.
   b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Available Manufacturers:
   a. Perfection Corp.
   b. Precision Plumbing Products, Inc.
   c. Sioux Chief Manufacturing Co., Inc.
   d. Victaulic Co. of America.

2.6 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 PLUMBING DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove plumbing 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 and purge if gases may exist and cap or plug piping with same or compatible piping material. Do not abandon piping above grade in accessible locations.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
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. Seal transition to existing materials.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 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 Coordination Drawings.

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 to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping susceptible to freezing conditions, so that the lines will drain completely. Provide low point drains in accessible locations or provide access doors for drain points.

I. Install piping free of sags and bends.

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

K. Install piping and hangers to allow application of insulation.

L. Select system components with pressure rating equal to or greater than system operating pressure.

M. Verify final equipment locations for roughing-in.

N. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 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. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Threaded Joints: Thread pipe with tapered pipe threads according to 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 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.

F. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.

D. Install equipment to allow right of way for piping installed at required slope.
3.6 PAINTING

A. Painting of plumbing systems, equipment, supports and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

C. Paint all new and re-installed interior and exterior natural gas piping.

D. Paint exterior fuel piping.

E. Clean and degrease all piping prior to painting.

3.7 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 6 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 the 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. Scarify existing concrete surfaces. Clean surfaces and remove oils to allow a bond with the existing and new concrete.

8. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Miscellaneous Cast-in-Place Concrete."

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

D. Prime and paint all black iron and galvanized field or shop fabricated piping, equipment supports, stands, hangers, etc.
3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment. All wood blocking, nailers, etc. must be fire resistant.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.10 GROUTING

A. Mix and install grout for plumbing 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 leveling bed of grout for floor mounted mop sinks.

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 220500
SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

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. Sleeves.
   2. Sleeve-seal systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed.

E. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
2.2  SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Advance Products & Systems, Inc.
2. Metraflex Company (The).
3. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3  GROUT


B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 3000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1  SLEEVE INSTALLATION

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 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. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. 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 above finished floor level.
3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

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 annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION
   A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
   B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, 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.

3.3 SLEEVE-SEAL-FITTING INSTALLATION
   A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
   B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
   C. Secure nailing flanges to concrete forms.
   D. Using grout, seal the space around outside of sleeve-seal fittings.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE
   A. Use sleeves and sleeve seals for the following piping-penetration applications:
      1. Exterior Concrete Walls above Grade:
         a. Piping Smaller Than NPS 6: Cast-iron wall sleeves or Sleeve-seal fittings.
         b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves.
      2. Exterior Concrete Walls below Grade:
a. Piping Smaller Than NPS 6: Cast-iron or PVC wall sleeves.
   1) Select sleeve size to allow for 1-inch annular clear space between piping and
      sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
   1) Select sleeve size to allow for 1-inch annular clear space between piping and
      sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:
   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and
         sleeve for installing sleeve-seal system.
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and
         sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

5. Interior Partitions:

END OF SECTION 220517
SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

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. Escutcheons.
      2. Floor plates.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS
   A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
   B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and
      spring-clip fasteners.
   C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
   D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and
      setscrew.
   E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip
      fasteners.

2.2 FLOOR PLATES
   A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
   B. Split-Casting Floor Plates: Cast brass with concealed hinge.
PART 3 - EXECUTION

3.1 INSTALLATION

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.

1. Escutcheons for New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
   c. Insulated Piping: One-piece, stamped-steel type or stamped-steel type with concealed hinge.
   d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   g. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. 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: One-piece, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 220518
SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

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. Liquid-in-glass thermometers.
   2. Thermowells.
   3. Dial-type pressure gages.
   4. Gage attachments.
   5. Test plugs.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS
A. Product Certificates: For each type of meter and gage.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE
A. ICC Plumbing Code and New York State Supplement to the Uniform Code.
B. State Education Department Planning Standards.
C. NSF Compliance: NSF 61 for valve materials for potable-water service and NSF 372 for lead-free.
PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
   a. Ashcroft, Inc.
   b. Marsh Bellofram.
   c. Trerice, H. O. Co.
   d. Weiss Instruments. Inc.
   e. Weksler Glass Thermometer Corp.

2. **Standard:** ASME B40.200.

3. **Case:** Cast aluminum; 6-inch nominal size.

4. **Case Form:** Back angle unless otherwise indicated.

5. **Tube:** Glass with magnifying lens and blue or red organic liquid.

6. **Tube Background:** Non-reflective aluminum with permanently etched scale markings graduated in deg F.

7. **Window:** Glass or plastic.

8. **Stem:** Aluminum or brass and of length to suit installation.
   a. Design for Thermowell Installation: Bare stem.

9. **Connector:** 3/4 inch, with ASME B1.1 screw threads.

10. **Accuracy:** Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

1. **Standard:** ASME B40.200.

2. **Description:** Pressure-tight, socket-type fitting made for insertion into piping tee fitting.

3. **Material for Use with Copper Tubing:** CNR.

4. **Material for Use with Steel Piping:** CRES.

5. **Type:** Stepped shank unless straight or tapered shank is indicated.

6. **External Threads:** NPS 3/4, ASME B1.20.1 pipe threads.

7. **Internal Threads:** 3/4, with ASME B1.1 screw threads.

8. **Bore:** Diameter required to match thermometer bulb or stem.

9. **Insertion Length:** Length required to match thermometer bulb or stem.

10. **Lagging Extension:** Include on thermowells for insulated piping and tubing.

11. **Bushings:** For converting size of thermowell's internal screw thread to size of thermometer connection.

B. **Heat-Transfer Medium:** Mixture of graphite and glycerin.
2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   
   a. Ashcroft Inc.
   b. Marsh Bellofram.
   c. Trerice, H. O. Co.
   d. Weiss Instruments, Inc.
   e. Weksler Glass Thermometer Corp.


3. Case: Sealed type; cast aluminum or drawn steel; 4-1/2-inch nominal diameter.

4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.

5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.

6. Movement: Mechanical, with link to pressure element and connection to pointer.

7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.


9. Window: Glass or plastic.

10. Ring: Metal.

11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass ball, Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Flow Design, Inc.
2. Peterson Equipment Co., Inc.
4. Trerice, H. O. Co.
5. Weiss Instruments, Inc.
6. Weksler Glass Thermometer Corp.

B. Description: Test-station fitting made for insertion into piping tee fitting.
C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending a minimum of 2 inches into fluid 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 direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids.

H. Install test plugs in piping tees.

I. Install thermometers in the following locations:

   1. Outlet of each instantaneous water heater.

J. Install pressure gages in the following locations:

   1. Water service exiting building to Concession Stand.
   2. Pump discharge serving dust collector sprinkler system.
   3. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
3.3 ADJUSTING
   A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE
   A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:
      2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.
   B. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be one of the following:
      2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.
   C. Thermometers at outlet of each domestic hot-water mixing valve shall be one of the following:
      2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.
   D. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE
   A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F.
   B. Scale Range for Domestic Hot-Water Piping: 0 to 150 deg F.

3.6 PRESSURE-GAGE SCHEDULE
   A. Pressure gages in the domestic water system shall be one of the following:
      1. Sealed, direct-mounted, metal case.
      2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.
   B. Compressed Air Piping shall be one of the following:
      1. Sealed directed mounted Case with snubber.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE
   A. Scale Range for Water Service Piping: 0 to 160 psi.
   B. Scale Range for Domestic Water Piping: 0 to 100 psi.
   C. Scale Range for Compressed Air Piping: 0 to 160 psi.
SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

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. Bronze ball valves.
      2. Bronze swing check valves.
   B. Related Sections:
      1. Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
      2. Section 221116 "Domestic Water Piping" for valves applicable only to this piping.

1.3 DEFINITIONS
   A. CWP: Cold working pressure.
   B. EPDM: Ethylene propylene copolymer rubber.
   C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
   D. NRS: Nonrising stem.
   E. RS: Rising stem.
   F. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE
   A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service and NSF 372 for lead-free.

D. ICC Plumbing Code and the New York State supplement to the Uniform Code.

E. State Education Department Planning Standards.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
4. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Hand wheel: For valves other than quarter-turn types.
2. Hand lever: For quarter-turn valves NPS 6 and smaller.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
F. Valve-End Connections:
   1. Solder Joint: With sockets according to ASME B16.18.
   2. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers
      offering products that may be incorporated into the Work include, but are not limited to,
      the following:
      a. American Valve, Inc.
      b. Conbraco Industries, Inc.; Apollo Valves.
      c. Crane Co.; Crane Valve Group; Crane Valves.
      d. Hammond Valve.
      e. Milwaukee Valve Company.
      f. NIBCO INC.
      g. Red-White Valve Corporation.
      h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

   2. Description:
      b. SWP Rating: 150 psig.
      c. CWP Rating: 600 psig.
      d. Body Design: Two piece.
      e. Body Material: Bronze.
      f. Ends: Threaded.
      g. Seats: PTFE or TFE.
      h. Stem: Bronze.
      i. Ball: Chrome-plated brass.
      j. Port: Full.

B. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers
      offering products that may be incorporated into the Work include, but are not limited to,
      the following:
      b. Crane Co.; Crane Valve Group; Crane Valves.
      c. Hammond Valve.
      d. Milwaukee Valve Company.
      e. NIBCO INC.
      f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.

2.3 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. American Valve, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Hammond Valve.
   d. Milwaukee Valve Company.
   e. NIBCO INC.
   f. Powell Valves.
   g. Red-White Valve Corporation.
   h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   a. Standard: MSS SP-80, Type 3.
   b. CWP Rating: 200 psig.
   c. Body Design: Horizontal flow.
   e. Ends: Threaded.
   f. Disc: Bronze.

2.4 STAINLESS STEEL BALL VALVES

A. Standard -Port, 316 SS Ball Valves machined from a billet with ss trim:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Swagelok, AFS Series
   b. Approved Equal.
2. Description:
   a. CWP Rating: 4,200 psig minimum.
   c. Body Material: 316 SS.
   d. Ends: Swagelok compression.
   e. Seals: PEEK/Florocarbon and PTFE.
   f. Stem: SS.
   g. Ball: SS.
   h. Port: Standard.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

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

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball or gate valves.
2. Throttling Service: Ball valves.
3. Pump-Discharge Check Valves:
   a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
4. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, bronze with bronze or stainless-steel trim.
3. Bronze Swing Check Valves: Class 125, bronze disc.

3.6 COMPRESSED AIR SERVICE VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Smaller:

1. Bronze Valves: 2 Threaded ends.
2. Ball Valves: Two piece, full port, bronze with bronze or stainless-steel trim.
3.7 GREASE/ LUBRICATION PIPING, VALVE SCHEDULE.

A. Tubing, 3/4” O.D. and smaller.
   1. 316 Stainless Steel Valve: Swagelok Compression end.
   2. Ball Valves: Mono-block, machined from billet.

END OF SECTION 220523
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. Metal Framing Systems
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Pipe positioning systems.
8. Equipment supports.

B. Related Sections:

1. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. 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.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

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

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

C. ICC Plumbing Code, New York State Supplement to Uniform code.

D. State Education Department Planning Standards.

PART 2 - PRODUCTS

2.1 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 or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, 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.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. **B-line, an Eaton business.**
   b. **Flex-Strut Inc.**
   c. **Unistrut; Part of Atkore International.**

2. **Description:** Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.

3. **Standard:** MFMA-4.

4. **Channels:** Continuous slotted steel channel with inturned lips.

5. **Channel Nuts:** Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

6. **Hanger Rods:** Continuous-thread rod, nuts, and washer made of carbon steel.

7. **Metallic Coating:** Electroplated zinc.

**B. Non-MFMA Manufacturer Metal Framing Systems:**

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. **Anvil International.**
   b. **Empire Industries, Inc.**
   c. **ERICO International Corporation.**
   d. **PHD Manufacturing, Inc.**
   e. **PHS Industries, 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.

4. **Channels:** Continuous slotted steel channel with inturned lips.

5. **Channel Nuts:** Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

6. **Hanger Rods:** Continuous-thread rod, nuts, and washer made of carbon steel.

7. **Coating:** Zinc.

**2.4 THERMAL-HANGER SHIELD INSERTS**

**A. Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. **Carpenter & Paterson, Inc.**
2. **ERICO International Corporation.**
3. **National Pipe Hanger Corporation.**
4. **PHS Industries, Inc.**
5. **Pipe Shields Inc.**
B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig or ASTM C 591, 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.

2.5 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.

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

2.6 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: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:
   1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
   3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
   4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
   5. Provided with manufacturer’s recommended bracing for compliant with wind restraint requirements.
2.7 PIPE POSITIONING SYSTEMS

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

2.8 EQUIPMENT SUPPORTS

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

2.9 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. 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 A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

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

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

E. 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.

F. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

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

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


J. 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.

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

L. 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.

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

N. 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.

O. 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.

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 same thickness as piping insulation.

3.2 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.

3.3 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 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.
3.4 **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.

3.5 **PAINTING**

A. Touchup: 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.

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 A 780.

C. All field or shop fabricated steel pipe supports and stands, equipment supports and stands as well as any steel fabricated pieces must be primed and painted.

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-69 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, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and copper 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. 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.
4. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
6. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
7. 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.
8. 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.
9. 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 might occur and vertical adjustment is not necessary.
10. 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 might be required in addition to expansion and contraction.

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 Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
2. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
4. 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. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

8. 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.

9. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

10. 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. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

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

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

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

END OF SECTION 220529
SECTION 220553 - IDENTIFICATION 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. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Stencils.
   5. Valve tags.
   6. Warning tags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
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.
D. Valve numbering scheme.
E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. ICC Plumbing Code and New York State Supplement to the Uniform Code.
B. State Education Department Planning Standards.
2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Brady Corporation.
   b. Brimar Industries, Inc.
   c. Craftmark Pipe Markers.
   d. Marking Services, Inc.
   e. Seton Identification Products.

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.


4. Background Color: Black.

5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.


9. 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.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Craftmark Pipe Markers.
4. Marking Services Inc.
5. Seton Identification Products.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

C. Letter Color: Black.

D. Background Color: Yellow.

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

H. Fasteners: Stainless-steel rivets or self-tapping screws.

I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Brady Corporation.
2. Brimar Industries, Inc.
3. Craftmark Pipe Markers.
4. Marking Services Inc.
5. Seton Identification Products.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.4 STENCILS

A. Stencils for Piping:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Brimar Industries, Inc.
   b. Craftmark Pipe Markers.
   c. Marking Services Inc.

2. Lettering Size: Size letters according to ASME A13.1 for piping.


4. Stencil Paint: Exterior, gloss, alkyd enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

5. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

2.5 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Craftmark Pipe Markers.
4. Marking Services Inc.
5. Seton Identification Products.

B. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass wire-link chain, beaded chain or S-hook.

C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.
2.6 WARNING TAGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Craftmark Pipe Markers.
4. Marking Services Inc.
5. Seton Identification Products.

B. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION 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.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.
3.4 PIPE LABEL INSTALLATION

A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.

1. Identification Paint: Use for contrasting background.

B. 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. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

D. Pipe Label Color Schedule:

1. Domestic Water Piping
   a. Background: Green.

2. Sanitary, Waste, Vent and Storm Drainage Piping:
   a. Background Color: Gray.
   b. Letter Color: Black.

3. Pump Discharge Piping:
   a. Background Color: Gray.
   b. Letter Color: Black.

4. Natural Gas Piping:
   a. Background Color: Yellow.
   b. Letter Color: Black.
5. Compressed Air Piping:
   a. Background Color: Blue.

6. Lubrication Oil and Lubrication Grease Piping:
   a. Background Color: Yellow.
   b. Letter Color: black.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve tags shall be an extension of the existing valve tagging scheme, with not duplicate numbers, verify existing scheme.

C. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:
   c. Natural Gas: 1-1/2” round.
   d. Compressed Air: 1-1/2” round.
   e. Lubrication Oil and Grease: 1-1/2” round.

2. Valve-Tag Colors:
   a. Domestic Cold Water: Natural.
   b. Domestic Hot and Recirculating Water: Natural.
   c. Natural Gas: Yellow.
   d. Compressed Air Piping; black
   e. Lubrication Oil and Grease: Yellow.

3. Letter Colors:
   a. Domestic Cold Water: Black.
   b. Domestic Hot and Recirculating Water: Black.
   c. Natural Gas: Black
   d. Compressed Air Piping; White
   e. Lubrication Oil and Grease: White.
3.6 VARIOUS-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

B. Provide placards, operating instructions and NFPA 704 Identification for fuel dispensers, tanks and fuel monitoring system.

END OF SECTION 220553
SECTION 220719 - PLUMBING PIPING INSULATION

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 insulating the following plumbing piping services:
      1. Domestic cold-water piping.
      2. Domestic hot-water piping.
      3. Domestic recirculating hot-water piping.
      4. Supplies and drains for handicap-accessible lavatories and sinks.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor
      permeance thickness, and jackets (both factory- and field-applied, if any).

1.4 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For qualified Installer.
   B. Material Test Reports: From a qualified testing agency acceptable to authorities having
      jurisdiction indicating, interpreting, and certifying test results for compliance of insulation
      materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates
      of tests and test methods employed.
   C. Field quality-control reports.

1.5 QUALITY ASSURANCE
   A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship
      program or another craft training program certified by the Department of Labor, Bureau of
      Apprenticeship and Training.
   B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing
      identical products according to ASTM E 84 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. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. Comply with the following applicable standards and other requirements specified for miscellaneous components:


E. State Education Department Planning Standards.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing 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.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General" and "Indoor 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 in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   - *CertainTeed Corporation.*
   - *Johns Manville; a Berkshire Hathaway company.*
   - *Knauf Insulation.*
   - *Owens Corning.*

F. Mineral-Fiber, Preformed Pipe Insulation:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   - *Johns Manville; a Berkshire Hathaway company.*
   - *Knauf Insulation.*
   - *Owens Corning.*

2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS


1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   - *Ramco Insulation, Inc.*

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   - *Ramco Insulation, Inc.*

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. Ramco Insulation, Inc.

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.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller Construction Products.
   c. Mon-Eco Industries, Inc.

2. **Adhesive:** As recommended by mineral fiber manufacturer and with a VOC content of 80 g/L or less.


1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller Construction Products.
   c. 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Dow Corning Corporation.
   b. Johns Manville; a Berkshire Hathaway company.
   c. Speedline Corporation.

2. **Adhesive:** As recommended by Adhesive - PVC Jacket manufacturer and with a VOC content of 50 g/L or less.
2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   1. **Mastics**: As recommended by insulation manufacturer and with a VOC content of 50 g/L or less.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
   1. **Manufacturers**: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Foster Brand; H. B. Fuller Construction Products.
      b. Knauf Insulation.
      c. Vimasco Corporation.
   2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
   1. **Manufacturers**: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Brand; H. B. Fuller Construction Products.
      b. Foster Brand; H. B. Fuller Construction Products.
      c. Mon-Eco Industries, Inc.
      d. Vimasco Corporation.
   2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: 60 percent by volume and 66 percent by weight.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
   1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. **Manufacturers**: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller Construction Products.
   c. Vimasco Corporation.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.

4. **Service Temperature Range**: 0 to plus 180 deg F.
5. **Color**: White.

### 2.6 SEALANTS

#### A. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. **Manufacturers**: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand; H. B. Fuller Construction Products.

2. Materials shall be 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.
5. **Color**: White.

### 2.7 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 C 1136, Type I.

### 2.8 FIELD-APPLIED CLOTHS

#### A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

1. **Manufacturers**: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Johns Manville; a Berkshire Hathaway company.
   b. P.I.C. Plastics, Inc.
   c. Proto Corporation.

2. Adhesive: As recommended by jacket material manufacturer.
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.

2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Avery Dennison Corporation, Specialty Tapes Division.
   b. Compac Corporation.
   c. Knauf Insulation.
   d. Venture Tape.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Compac Corporation.
   c. Venture Tape.

2. Width: 2 inches.

3. Thickness: 6 mils.


5. Elongation: 500 percent.

6. Tensile Strength: 18 lbf/inch in width.

### 2.11 SECUREMENTS

**A. Bands:**

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. ITW Insulation Systems; Illinois Tool Works, Inc.
   b. RPR Products, Inc.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.

3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.

**B. Staples:** Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

**C. Wire:** 0.080-inch nickel-copper alloy or 0.062-inch soft-annealed, stainless steel.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

### 2.12 PROTECTIVE SHIELDING GUARDS

**A. Protective Shielding Pipe Covers:**

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Insul-Tect Products Co.
b. McGuire Manufacturing.
c. Truebro.
d. Zurn Industries, LLC.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

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

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

1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

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

3.3 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 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, soften, or otherwise attack insulation or jacket in either wet or dry state.
D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

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

F. Keep insulation materials dry during application and finishing.

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.
   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.

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.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. 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 4 inches 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 pipe flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

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 beyond damaged areas. Adhere, staple, and seal patches similar 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.

3.4 PENETRATIONS

A. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Seal penetrations with flashing sealant.
   1. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint 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."

3.5 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.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as 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 preformed fitting insulation or sectional pipe insulation of same material and thickness as 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 preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two 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 or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two 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 and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. For services not specified to receive a field-applied jacket except for flexible elastomeric, 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.

8. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps and test connections 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 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 adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two 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 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.

3.6 INSTALLATION OF MINERAL-FIBER 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 factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied 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 preformed 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 mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as 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 preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered 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.
3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch 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.

3.8 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. 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 three 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 Work if sample inspection reveals noncompliance with requirements.

3.9 PIPING INSULATION SCHEDULE, GENERAL

A. 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.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. NPS 1 and Smaller: Insulation shall be one of the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
2. NPS 1-1/4 and Larger: Insulation shall be one of the following:
a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:
   1. NPS 1-1/4” and Smaller: Insulation shall be one of the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
   2. NPS 1-1/2” and Larger: Insulation shall be one of the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2” inch thick.

C. Stormwater and Overflow:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

D. Roof Drain and Overflow Drain Bodies:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
   1. Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

3.11 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, fittings only:
   1. PVC: 20 mils thick.

D. Piping, Exposed:
   1. PVC: 20 mils thick.

END OF SECTION 220719
SECTION 220800 – PLUMBING SYSTEM COMMISSIONING

PART 1-GENERAL

1.1 WORK INCLUDED

A. Systems and equipment testing and start-up.
B. Validation of proper and thorough installation of Division 22 (Plumbing) systems and equipment.
C. Systems balancing verification.
D. Domestic Water System pressure tests.
E. Domestic Hot Water System Temperature settings.
F. Prefunctional performance testing of equipment and systems.
G. Documentation of tests, procedures, and installations.
H. Coordination of Training Events.
I. Generic Start-Up Procedures for plumbing systems and equipment.
J. Factory Start-Up by authorized representative for specific equipment.

1.2 GENERAL DESCRIPTION

A. Commissioning (Cx) is the process of ensuring that all building systems are installed and perform interactively according to the design intent; that systems are efficient and cost effective and meet the Owner’s operational needs; that the installation is adequately documented; and that the Operators are adequately trained. It serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance the building systems from installation to full dynamic operation and optimization.
B. Commissioning Authority (CA) is retained by the [DM][Owner] shall work with the Contractor and the Design Engineer to direct and oversee the Cx process and perform functional performance testing.
C. This Section outlines the Cx procedures specific to the Division 22 Contractors. Requirements common to all Sections are specified in Sections 01 91 00 and 01 91 10 and the Cx Plan.

1.3 SCOPE

A. The following are included in the Scope of Commissioning on this project:
   1. Plumbing Systems
   2. Compressed Air Systems and Equipment
   3. Heater Pressure Washer Equipment
   5. Natural Gas Systems

1.4 RELATED WORK AND DOCUMENTS

A. Commissioning Plan: The Commissioning Plan outlines the commissioning process beyond the construction specification. All Contractor responsibilities are outlined in
COMMISSIONING OF PLUMBING

Specifications. Cx Plan is available to the Contractor to understand the context of their responsibilities but does not define any additional responsibilities of the Contractor
B. Section 01 91 00 – General Commissioning Requirements: details the Cx requirements common across all divisions
C. Section 01 91 10 – Functional Testing Procedures: Outlines the generic functional testing procedures required.
D. Section 01 91 20 – Representative Cx Forms: Presents representative forms that will track and document the start up and testing process as well as the overall Cx process.
E. Individual Specification Sections: Individual sections stipulate installation, start-up, warranty, O&M documentation, and training requirements for the system or device specified in the Section.
F. Section 23 08 00 – HVAC Systems Commissioning: Details the commissioning procedures specific to HVAC (Div 23) work.
G. Section 23 08 01 – Building Automation Systems Commissioning: Details the commissioning procedures specific to the Building Automation System.
H. Section 28 08 10 - Security Systems Commissioning: Details the commissioning procedures specific to Security System.
I. Section 26 08 00 – Electrical Systems Commissioning: Details the commissioning procedures specific to Division 26 work.
J. Section 28 08 20 – Fire Alarm Systems Commissioning: Details the commissioning procedures specific to the Fire Alarm Systems.

1.5 DEFINITIONS AND ABBREVIATIONS
A. Refer to Section 01 91 00

1.6 REFERENCE STANDARDS
B. ASHRAE Guideline 4-1993, “Preparation of operating and Maintenance Documentation for Building Systems”

1.7 DOCUMENTATION
A. In addition to the documentation required in Section 01 91 00, Contractor shall provide to the CA the following per the procedures specified herein, in the Cx Plan, and in other Sections of the specification:

1. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to Acceptance Phase. Factory Test Reports should be provided in pdf electronic format. These may include but are not limited to:
   a) Air Compressors and dryers.
   b) Heated Power Washers
   d) Electric Instantaneous Water Heaters

2. Field Testing Agency Reports (other than TAB): Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase. Field Testing Agency Reports should be provided in pdf electronic format. These may include but are not limited to:
   a) Pipe Pressure Testing
   b) Potable Water Disinfection
c) Pure Water Testing  
d) Pressure Testing  
e) Domestic Hot Water Temperature set points.  
f) Vibration Testing  
g) Generated Noise and Resultant Noise Level  
h) Corrosion Protection 

1.8 SEQUENCING AND SCHEDULING  
A. Refer Section 01 91 00 

1.9 COORDINATION MANAGEMENT PROTOCOLS  
A. Coordination responsibilities and management protocols relative to Cx are initially defined in Section 01 91 00 and the Commissioning Plan, but shall be refined and documented in the Construction Phase Cx Kick-Off meeting. Contractor shall have input in the protocols and all Parties will commit to scheduling obligations. The CA will record and distribute. 

1.10 CONTRACTOR RESPONSIBILITIES  
A. Refer to Section 01 91 00: Detailed Contractor responsibilities common to all Divisions are specified in Section 01 91 00. The following are additional responsibilities or notable responsibilities specific to Division 22.  
B. Construction Phase  
1. Provide skilled technicians qualified to perform the work required.  
2. Provide factory-trained and authorized technicians where required by the Contract Documents.  
3. Prepare and submit required draft Start-Up Procedures and submit along with the manufacturer’s application, installation and start-up information.  
4. Provide assistance to the CA in preparation of the specific Functional Performance Test (FPT) procedures. Contractors, subcontractors and vendors shall review FPT procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests. Damage caused to equipment performed in accordance with the approved procedures will be the responsibility of the Contractor.  
5. Thoroughly complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference or industry standards, and as specifically indicated elsewhere this Section.  
6. Start-up, and test/adjust/balance systems and equipment prior to functional performance testing by the CA. Start-Up Procedures shall be in accordance with Contract Documents, reference or industry standards, and specifically elsewhere in Part I of this Section.  
7. Record Start-up Procedures on start-up procedure forms and certify that the systems and equipment have been started and or tested in accordance with the requirements specified above. Each task or item shall be indicated with the Party actually performing the task or procedure.  
C. Acceptance Phase  
1. Assist CA in functional performance testing. Assistance will generally include the following:
a) Manipulate systems and equipment to facilitate testing (as dictated in Section 01 91 10; in some cases this will entail only an initial sample);
b) Provide any specialized instrumentation necessary for functional performance testing;

D. Warranty Phase
1. Maintain record documentation of any configurations, set ups, parameters etc, that change throughout the period.
2. Provide representative for off season testing as required by CA.
3. Respond to Warranty issues as required by Division 1 and the General Conditions.

1.11 EQUIPMENT SUPPLIER RESPONSIBILITIES
A. Refer to Section 01 91 00.

1.12 Contractor Notification AND SCHEDULING
A. Refer to Section 01 91 00.

1.13 START-UP PROCEDURES AND DOCUMENTATION
A. Refer to Section 01 91 00.

1.14 Equipment Nameplate Data
A. Refer to Section 01 91 00.

1.15 Functional Performance Testing
A. Contractor shall participate in the initial samples of Functional Performance Testing as stipulated in Section 01 91 00 and Section 01 91 10.

1.16 FPT Acceptance Criteria
A. Acceptance criteria for tests are indicated in Section 01 91 10 and in the specification Sections applicable to the systems being tested. Generally, unless indicated otherwise, the criteria for acceptance will be that specified with the individual system, equipment, component, or device.

1.17 Training
A. Contractors, Subcontractor, Vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for per the requirements of Section 01 91 00 and the individual Specifications.

1.18 Facility Manual Content - Preparation and Logistics
A. Refer to Section 01 91 00 the individual Specifications.

PART 2. PRODUCTS

2.1 INSTRUMENTATION
A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply:
1. Temperature sensors and digital thermometers shall have a certified calibration within the past year and a resolution of + or - 0.1°F.
2. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.
3. All equipment shall be calibrated according to the manufacturer’s recommended intervals. Calibration tags shall be affixed or certificates readily available.
B. Standard Testing Instrumentation: Standard instrumentation used for testing air and water flows, temperatures, humidity, noise levels, amperage, voltage, and pressure differential in air and water systems shall be provided by CA.

C. Special Tools: Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and turned over to the Owner upon project completion.

2.2 Web-based commissioning portal

A. All general and major subcontractors participating in the Cx process shall use the web-based Cx Portal (‘Portal’) to document the Cx procedures. The Portal is a Web-based Internet hub used to electronically collaborate and coordinate activities and deliverables throughout the Cx process. The Portal is hosted by the CxA and shall be accessible to all Parties participating in the Cx program. The Portal provides a common location to store Start-Up Documentation, Functional Performance Tests and results, project documents and deliverables. It also serves as a collaborative email hub to facilitate, automate, and track communications between Parties relating to the Cx process.

B. Refer to Section 01 91 00 the individual Specifications for additional information and requirements for using the Portal.

2.3 TEST KITS FOR METERS AND GAGES

A. Test kits for meters and gages shall be provided to the Owner new and in good condition. Previously used kits will be unacceptable. Kits shall be submitted prior to the Acceptance Phase. Kits included shall be as a minimum:

1. Digital indication of temperature and pressure with associated sensors to work with the P/T test ports
2. Companion readout kit (with fittings) for calibrated balancing valve with ranges as required by all devices on this project

PART 3. EXECUTION

3.1 START-UP PROCEDURES - GENERAL

A. The Division 22 technical sections and Part III of this Section outlines ‘generic’ or minimally acceptable Start-Up Procedures (delineated as Start-Up Checks and Start-Up Tests) and individual systems Training requirements for systems and equipment. These procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct per normal quality control practices. These items shall provide a minimum or guideline for required Contractor development of Start-Up Procedures. Contractor shall synthesize these minimum requirements along with their own internal quality control practices, those of the manufacturer, and any applicable codes and standards to develop specific and itemized Start-Up Procedures specific to the equipment and systems installed on this project.

3.2 PROCEDURES COMMON TO ALL SYSTEMS

A. The following start up verifications/procedures are common to all systems
B. Checkout shall proceed from devices to the components to the systems.
C. Verify labeling is affixed per spec and visible
D. Verify prerequisite procedures are done.
E. Inspect for damage and ensure none is present.
F. Verify system is applied per the manufacturer’s recommendations
G. Verify system has been start up per the manufacturer’s recommendations
H. Verify that access is provided for inspection, operation and repair
I. Verify that access is provided for replacement of the equipment
J. Verify the record drawings, submittal data and O&M documentation accurately reflect the installed systems
K. Verify all gages and test ports are provided as required by contract documents and manufacturer’s recommendations
L. Verify all recorded nameplate data is accurate
M. Installation is done to ensure safe operation and maintenance.
N. Verify specified replacement material/attic stock has been provided as required by the Construction Documents
O. Verify all rotating parts are properly lubricated
P. Verify all monitoring and ensure all alarms are active and set per Owner’s requirements
Q. Complete all nameplate data and confirm ratings conform with the design documents

3.3 VALVES
A. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:
   1. Operate all valves, manual and automatic, through their full stroke. Ensure smooth operation through full stroke and appropriate sealing or shutoff.
   2. Verify actuators are properly installed with adequate clearance.
   3. Verify all valves are labeled per the construction documents. Confirm that concealed valves are indicated on the finished building surface.
   4. For automatic pneumatically-operated valves, verify spring range and adjust pilot positioners where applicable. For electronically operated valves, check the stroke and range. For all automated valves controlled by a program, ensure that the minimum and maximum stroke and ranges on the valves are coordinated with the limits entered in the program.

3.4 METERS AND GAGES
A. Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:
   1. Verify correct gauge ranges for application.
   2. Adjust faces of meters and gages to proper angle for best visibility.
   3. Clean windows of meters and gages and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint. For meters and gages requiring temporary manual connection of read-out device such as pressure taps on a flow measuring device, ensure threads are clean and that connection can be made easily.
   4. Meters and gages requiring manual connection of readout device shall be installed with adequate access to allow connection of device with normal tools.

3.5 MECHANICAL IDENTIFICATION
A. Start-Up Checks: Perform the following checks:
1. Verify all valve tags, piping, duct, and equipment labeling corresponds with drawings and indexes and meets requirements specified. Correct any deficiencies for all piping and duct systems.
2. **Adjusting**: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
3. **Cleaning**: Clean face of identification devices, and glass frames of valve charts.

### 3.6 MECHANICAL INSULATION

**A.** Start-Up Checks: Examine all piping, systems and equipment specified to be insulated.
   1. Ensure quality of insulation. Patch and repair all insulation damaged after installation.
   2. Ensure the integrity of vapor barrier around all cold surfaces.

### 3.7 PIPING - GENERAL

**A.** Start-Up Checks: These Procedures apply to all installed piping systems, including underground site utilities.
   1. Inspect all piping for proper installation, adequate support (with appropriate vibration isolation where applicable) and adequate isolation valves for required service.
   2. Submit welding certifications as required by the applicable specification section or referenced ASME specification.
   3. Submit certified welding inspection results per the applicable specification section or referenced ASME specification. ASME B31.1 requires 100% inspection based on pressure class.
   4. Provide notification of pipe cleaning and flushing activities
   5. Flush and clean all piping and clean all strainers. Provide documentation of all related procedures.
   6. Ensure adequate drainage is provided at low points and venting is provided at high points.
   7. Ensure air is thoroughly removed from the system as applicable. Ensure facilities to effectively drain and fill the system are in place.
   8. Ensure all piping is adequately supported and anchored to allow expansion. Bump across-the-line pumps and inspect for excessive pipe movement.
   9. Provide notification of pressure testing
   10. Pressure and/or leak test all applicable systems in accordance with the requirements in the applicable sections, ASME B 31.1 and 39.1 as applicable.
   11. Sterilize applicable piping systems as specified in the individual Sections and as required by regulatory authorities.
   12. Submit pressure test reports that document the pressure testing results with Certification of the results.
   13. Verify the operation of applicable safety relief valves, operating controls, safety controls, etc. to ensure a safe installation.
   14. Set and adjust fill, pressure, or level controls to the required setting.

### 3.8 AC MOTORS

**A.** Start-Up Checks: Perform the following checks during start-up and as specified in manufacturer's instructions:
   1. Verify proper alignment, installation, and rotation.
2. Verify properly sized overloads are in place

B. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up and as specified in manufacturer's instructions:
   1. Measure insulation resistance, phase balance, and resistance to ground.
   2. Measure voltage available to all phases. Measure amps and RPM after motor has been placed in operation and is under load.
   3. Record all motor nameplate data.

3.9 Bearings
A. This applies to all bearings on fans, pumps, compressors, etc.
B. Use infrared thermometer to measure temperature at peak conditions. Ensure temperature is below manufacturer’s recommendations.
C. Check alignment as applicable
D. For bearings in drives with motors over 10 HP, use a vibration meter and measure the maximum peak to peak acceleration. Compare it to the “Vibration Severity Chart”. Rectify any condition causing conditions indicated as “Rough” or worse.
E. Lubricate all bearings per the manufacturer's instructions. When bearing is used for temporary conditioning, lubricate on manufacturer’s recommended frequency and document it.

3.10 VARIABLE SPEED DRIVES
A. General: Provide the services of a factory-authorized service representative to test and inspect unit installation, provide startup service, and to demonstrate and train Owner's maintenance personnel as specified below.
B. Start-Up Checks: Perform the following checks before start-up and as specified in manufacturer's start-up instructions:
   1. Check unit for shipping damage.
   2. Perform a point-to-point continuity test for all field installed wiring interconnections. Verify terminations of field installed wiring.
   3. Check for proper torque on connections.
   4. Verify use of shielded cable where specified and check that shields have been terminated properly.
   5. Verify grounding.
   6. Check motor nameplate against drive input rating.
   7. Manually rotate motor shaft to ensure free rotation.
   8. Check that motor leads are not grounded.
C. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up and as specified in manufacturer's instructions:
   1. Ensure device and system which drive is serving is configured to withstand the device operation specified below.
   2. Adjust the Minimum Voltage Adjustment to enable starting but not to draw excessive power at start.
   3. Adjust the Volts/Hz adjustment to proper setting.
   4. Adjust the Acceleration and Deceleration rates to the specified times.
   5. Adjust Current Limiting to coordinate with the overcorrect device and protect the motor.
   6. Set the Maximum and Minimum speed pots.
   7. Manually ramp fan speed from minimum to maximum and check for excessive noise and vibration.
8. Determine any critical speeds to avoid and set these in the drive.
9. Check for acceptable voltage and current distortion on the power system. Record the input and output voltages and currents showing the harmonic content as a percentage of the base frequency.
10. Measure and record overall efficiency at 50%, 75%, and 100%.
11. Record the motor terminal voltage.

D. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.
   1. Review data in Operating and Maintenance Manuals.

3.11 AIR COMPRESSORS AND DRYERS

A. General: Provide the services of a factory authorized representative to inspect equipment installation and perform start-up of equipment. Train the Owner’s personnel in operation and maintenance.

B. Safety Controls: Operate and adjust safety controls. Replace damaged and malfunctioning controls and equipment.

C. Refer to AC Motors in this section

D. Start-Up Checks: Perform the following checks before start-up:
   1. Verify that specified tests of piping systems are complete.
   2. Check that air compressor and dryer inlets are properly located and free of debris.
   3. Check that air compressors and dryer inlet filters and piping is clear.
   4. Check for lubricating oil for lubricated-type equipment.
   5. Check V-belts for proper tension.
   6. Check for equipment vibration control supports and flexible pipe connectors and that equipment is properly attached to substrate.
   7. Check that safety (pressure relief) valves are properly set.
   8. Adjust dryer settings.
   9. Check for proper installation of drain valves and drain piping.
   10. Check for proper restraints and vibration isolation.
   11. Check for adequate room ventilation.

E. Start-Up Tests: Follow the manufacturers printed procedures as a minimum:
   1. Energize circuits.
   2. Start and run equipment through complete sequence of operations.
   3. Check for excessive vibration and noise.
   4. Check air pressures.
   5. Manually operate safety relief valves.
   6. Adjust operating controls including pressure settings.
   7. Adjust drain valve timers and throttles.

F. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.
   1. Review data in Operating and Maintenance Manuals.

3.12 HEATED PRESSURE WASHERS

A. General: Provide the services of a factory authorized representative to inspect equipment installation and start-up equipment, and train the Owner’s personnel
B. Safety Controls: Operate and adjust safety controls. Replace damaged and malfunctioning controls and equipment.

C. Refer to AC Motors in this section

D. Start-Up Checks: Perform the following checks before start-up:
   1. Verify that specified tests of piping systems are complete.
   2. Check that heated pressure washer connections are properly made.
   3. Check that heated pressure washer burner is operational, set for highest efficiency and that the venting system is working. Verify venting does not experience backdraft on start-up.
   4. Check for lubricating oil for lubricated-type equipment.
   5. Check V-belts for proper tension.
   6. Check for equipment vibration control supports and flexible pipe connectors and that equipment is properly attached to substrate.
   7. Check that safety (pressure relief or bypass) valves are properly set.
   8. Adjust temperature to below 140 deg. F.
   9. Check for soft water supply and verify that no cavitation occurs during operation.
   10. Check for proper pump operation.
   11. Check for proper seismic restraints.
   12. Check for adequate room ventilation.

E. Start-Up Tests: Follow the manufacturers printed procedures as a minimum:
   1. Energize circuits.
   2. Start and run equipment through complete sequence of operations.
   3. Check for excessive vibration and noise.
   5. Manually operate safety/bypass valves.
   6. Adjust operating controls including pressure and premature.

F. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.
   1. Review data in Operating and Maintenance Manuals.

G.

3.13 FUEL PUMPS, DISPENSING SYSTEM AND FUEL MANAGEMENT SYSTEM.

A. General: Provide the services of a factory authorized representative to inspect equipment installation and perform start-up of equipment. Train the Owner’s personnel in operation and maintenance.

B. Safety Controls: Operate and adjust safety controls. Replace damaged and malfunctioning controls and equipment.

C. Refer to AC Motors in this section

D. Start-Up Checks: Perform the following checks before start-up:
   1. Verify that specified tests of piping systems are complete.
   2. Check that Fuel system is installed secure and properly supported.
   3. Check that filters, hoses, swivels and break away connections are in place.
   4. Check for lubricating oil for lubricated-type equipment.
   5. Check and adjust safety relief/bypass valves.
   6. Check that safety (pressure relief) valves are properly set.
7. Check operation of emergency shut-down switch and anti-siphon valves are operating.
8. Check for proper fuel placards, no smoking signs, labels and Fire Marshal notices, signage and operating instructions are posted.

E. Start-Up Tests: Follow the manufacturers printed procedures as a minimum:
1. Energize circuits.
2. Start and run equipment through complete sequence of operations.
3. Check for excessive vibration and noise.
4. Check fuel flow and pressures.
5. Manually operate safety relief valves.
6. Adjust operating controls including pressure settings.
7. Test emergency shut-down system.
8. Test and calibrate Fuel Management System.
9. Confirm fuel dispenser measurement is accurate.
10. Confirm Fuel Management system records are collected and assigned to the correct account.

F. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.
1. Review data in Operating and Maintenance Manuals.

3.14 PLUMBING FIXTURES

A. Start-Up Checks: Perform the following checks during start-up:
1. Inspect each installed fixture for damage. Replace damaged fixtures and components.
2. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.
3. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
4. Operate and adjust disposers, hot water dispensers, and controls. Replace damaged and malfunctioning units and controls.
5. Adjust water pressure at drinking fountains, electric water coolers, and faucets, shower valves, and flushometers having controls, to provide proper flow and stream.
6. Replace washers of leaking and dripping faucets and stops.
7. Check that low point drains are provided in plumbing piping for seasonal buildings that do not have any heat.
8. Clean fixtures, fittings, and spout and drain strainers with manufacturers' recommended cleaning methods and materials
   a) During normal operation, systematically take redundant components out of service to simulate them being serviced or repaired. Ensure system continues operation without interruption. Demonstrate replacing filters and media.
9. Emergency Operation:
   a) Simulate failures of various components and sensors. Ensure proper responses to failures and proper enunciation of condition.
3.15 WATER HEATERS

A. General: Start-up services to be performed by a factory trained installer. Inspect unit installation, provide start-up service, demonstrate and train Owner's maintenance personnel as specified below.
   1. Adjust set points.
   2. Check for piping connections leaks.
   3. Check maximum temperature set point.
   4. Test and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment.

B. Training: Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.
   1. Review data in Operating and Maintenance Manuals.

3.16 NATURAL GAS SYSTEMS

A. Start-Up Tests: Perform the following tests, measurements, or procedures during start-up:
   1. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility requirements.
   2. Submit draft test forms and completed test forms to document and certify test results.

3.17 BREECHINGS, CHIMNEYS, AND STACKS

A. Start-Up Checks: Perform the following checks:
   1. Clean breechings internally during installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth.
   2. Check to ensure adequate draft throughout firing range and with all variations of multiple boilers
   3. Check that all roof penetrations are adequately sealed

3.18 FUEL-FIRED HEATERS

A. Start-Up Tests: Perform the following before or during start-up:
   1. Start-up, test, and adjust fuel-fired heaters in accordance with manufacturer's published start-up instructions.
   2. Adjust air diffusion louvers for proper air flow.
   3. Verify proper line and manifold gas pressure.
   4. Check and calibrate controls, adjust burner for maximum efficiency.

3.19 SEQUENCING ILLUSTRATION

A. Reference Section 01 91 00.

END OF SECTION 220800
SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Copper tube and fittings.
   2. Piping joining materials.
   3. Transition fittings.
   4. Dielectric fittings.

1.3 ACTION SUBMITTALS
A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS
A. System purging and disinfecting activities report.
B. Field quality-control reports.

1.5 FIELD CONDITIONS
A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
   1. Notify Construction Manager no fewer than two days in advance of proposed interruption of water service.
   2. Do not interrupt water service without Construction Manager's written permission.

1.6 QUALITY ASSURANCE
A. Plumbing Code of New York State.
B. State Education Department Planning Standards.
C. NSF Compliance: NSF 61 for valve materials for potable-water service and NSF 372 for lead-free.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Domestic water piping, support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

C. Comply with NSF Standard 372.

2.3 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.


D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

E. Copper Unions:
   1. MSS SP-123.
   4. Solder-joint or threaded ends.

2.4 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:
   1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
   2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.5 TRANSITION FITTINGS

A. General Requirements:
   1. Same size as pipes to be joined.
   2. Pressure rating at least equal to pipes to be joined.
   3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Dresser, Inc.
      c. JCM Industries, Inc.

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      b. HART Industrial Unions, LLC.
      c. Watts; a Watts Water Technologies company.
      d. Zurn Industries, LLC.

   3. Pressure Rating: 125 psig minimum at 180 deg F.

C. Dielectric Flanges:
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   b. Matco-Norca.
   c. Watts; a Watts Water Technologies company.
   d. Zurn Industries, LLC.

2. **Standard:** ASSE 1079.

3. **Factory-fabricated, bolted, companion-flange assembly.**
4. **Pressure Rating:** 125 psig minimum at 180 deg F.
5. **End Connections:** Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

**D. Dielectric Nipples:**

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Elster Perfection Corporation.
   b. Grinnell Mechanical Products.
   c. Precision Plumbing Products.

2. **Standard:** IAPMO PS 66.

3. **Electroplated steel nipple complying with ASTM F 1545.**
4. **Pressure Rating and Temperature:** 300 psig at 225 deg F.
5. **End Connections:** Male threaded or grooved.
6. **Lining:** Inert and noncorrosive, propylene.

**PART 3 - EXECUTION**

**3.1 PIPING INSTALLATION**

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 according to CDA's "Copper Tube Handbook."

C. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."

D. Install shutoff valve immediately upstream of each dielectric fitting.
E. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

F. Install domestic water piping so that it may be drained at the low points, especially where piping is installed in non-heated locations.

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

H. 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.

I. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

J. Install piping to permit valve servicing.

K. 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.

L. Install piping free of sags and bends.

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

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

O. Install thermometers on outlet piping from each instantaneous water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 JOINT CONSTRUCTION

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 according to 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. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. 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 according to ASME B31.9.

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

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

3.3 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.4 DIELECTRIC FITTING INSTALLATION

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

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings, unions or nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or nipples.

3.5 HANGER AND SUPPORT INSTALLATION

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

B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
DOMESTIC WATER PIPING

3.6 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.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

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

c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls.
   Support pipe rolls on trapeze.

4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
   2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
   3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   4. NPS 2-1/2: 108 inches with 1/2-inch rod.
   5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
   2. NPS 1-1/2: 108 inches with 3/8-inch rod.
   3. NPS 2: 10 feet with 3/8-inch rod.
   4. NPS 2-1/2: 11 feet with 1/2-inch rod.
   5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
   6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Support piping and tubing not listed in this article according to MSS SP-58 and manufacturer's written instructions.
1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.

2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.

3. 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 and larger.

3.7 IDENTIFICATION

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

B. Label pressure piping with system operating pressure.

3.8 FIELD QUALITY CONTROL

A. Perform the following 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:
      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 authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
   c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
   d. 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.
   c. Leave new, altered, extended, or replaced domestic water piping uncovered and 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 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. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.

f. 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.

3.9 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.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 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 according to either of the following:
      1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm 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. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

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

3.11 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be one of the following:

1. Soft copper tube, ASTM B 88, Type K; copper pressure-seal fittings; and pressure-sealed joints.

E. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and lead-free soldered joints.

F. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and lead-free soldered joints.

3.12 VALVE SCHEDULE

A. Refer to specifications for valve schedules.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116
SECTIONS 221119- DOMESTIC WATER PIPING SPECIALTIES

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. Vacuum breakers.
2. Backflow preventers.
3. Strainers.
4. Hose bibbs.
5. Wall hydrants.
6. Drain valves.
7. Water-hammer arresters.
8. Flexible Connectors.

B. Related Requirements:

1. Section 220519 "Meters and Gages for Plumbing Piping" for thermometers and pressure gage in domestic water piping.
2. Section 221116 "Domestic Water Piping" for piping materials.
3. Section 224716 "Pressure Water Coolers" for water filters for water coolers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.
1.6 QUALITY ASSURANCE

A. Plumbing Code of New York State.
B. State Education Department Planning Standards.
C. NSF Compliance: NSF 61 for valve materials for potable-water service and NSF 372.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61 Annex G.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Ames Co.
   b. Conbraco Industries, Inc.
   c. Watts; a Watts Water Technologies company.
   d. Zurn Industries, LLC.


3. Size: NPS 1/4 to NPS 3, as required to match connected piping.


5. Inlet and Outlet Connections: Threaded.

6. Finish: Rough bronze or Chrome plated.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Cash Acme.
   b. Watts; a Watts Water Technologies company.
   c. Woodford Manufacturing Company.
d. **Zurn Industries, LLC.**


5. Finish: Chrome plated or Rough bronze.

### 2.4 BACKFLOW PREVENTERS

#### A. Reduced-Pressure-Principle Backflow Preventers:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   - **Conbraco Industries, Inc.**
   - **FEBCO.**
   - **Watts; a Watts Water Technologies company.**
   - **Zurn Industries, LLC.**


3. Operation: Continuous-pressure applications.

4. Pressure Loss: 12 psig maximum, through middle third of flow range.

5. Size: As noted on plans.


7. End Connections: Threaded for NPS 2 and smaller.

8. Configuration: Designed for horizontal, straight-through flow.

9. Accessories:
   - **Valves NPS 2 and Smaller:** Ball type with threaded ends on inlet and outlet.
   - **Air-Gap Fitting:** ASME A112.1.2, matching backflow-preventer connection.

#### B. Hose-Connection Backflow Preventers:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   - **Conbraco Industries, Inc.**
   - **Watts; a Watts Water Technologies company.**
   - **Woodford Manufacturing Company.**


3. Operation: Up to 10-foot head of water back pressure.

4. Inlet Size: NPS 1/2 or NPS 3/4.

5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.

6. Capacity: At least 3-gpm flow.
2.5 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller.
3. End Connections: Threaded for NPS 2 and smaller.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
   a. Strainers NPS 2 and Smaller: 0.020 inch.
   b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.

2.6 HOSE BIBBS

A. Hose Bibbs:

4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
10. Finish for Finished Rooms: Chrome plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle or operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome-plated hose bibb.

2.7 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   b. Josam Company.
   c. Watts, a Watts Water Technologies company.
   d. Woodford Manufacturing Company.
   e. Zurn Industries, LLC.


4. Operation: Loose key.

5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.

6. Inlet: NPS 3/4 or NPS 1.


9. Operating Keys(s): One with each wall hydrant.

2.8 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:


2. Pressure Rating: 400-psig minimum CWP.


4. Body: Copper alloy.

5. Ball: Chrome-plated brass.


8. Inlet: Threaded or solder joint.


B. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.

2. Pressure Rating: 200-psig minimum CWP or Class 125.


5. Drain: NPS 1/8 side outlet with cap.

2.9 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   b. Precision Plumbing Products.
   c. Sioux Chief Manufacturing Company, Inc.
   d. Watts; a Watts Water Technologies company.
   e. Zurn Industries, LLC.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.10 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Unaflex, Inc.
2. Metraflex, Inc.
3. Flex-Hose Co., Inc.

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, 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. Install water-hammer arresters in water piping according to PDI-WH 201.

C. Install flexible connectors at connections to vibrating equipment and at building expansion joints. Coordinate with structural drawings for expansion joint locations.
3.2 CONNECTIONS
   A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."
   B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 FIELD QUALITY CONTROL
   A. Perform the following tests and inspections:
      1. Test each pressure vacuum breaker and reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
   B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
   C. Prepare test and inspection reports.

3.4 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.

END OF SECTION 221119
SECTION 221316 - SANITARY WASTE AND VENT PIPING

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. Pipe, tube, and fittings.
      2. Specialty pipe fittings.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS
   A. Field quality-control reports.

1.5 FIELD CONDITIONS
   A. Interruption of Existing Sanitary Waste 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 two days in advance of proposed interruption
         of sanitary waste service.
      2. Do not proceed with interruption of sanitary waste service without Construction
         Manager's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. Components and installation shall be capable of withstanding the following minimum working
      pressure unless otherwise indicated:
B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 PIPING MATERIALS

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

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

A. Pipe and Fittings: ASTM A 74, Service class.

B. Gaskets: ASTM C 564, rubber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   b. Fernco Inc.
   c. MIFAB, Inc.
   d. Mission Rubber Company, LLC; a division of MCP Industries.
   e. Tyler Pipe; a subsidiary of McWane Inc.


3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. ANACO-Husky.
   b. Charlotte Pipe and Foundry Company.
   c. Clamp-All Corp.
   d. Mission Rubber Company, LLC; a division of MCP Industries.
   e. Tyler Pipe; a subsidiary of McWane Inc.

3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.5 COPPER TUBE AND FITTINGS

A. Copper Type DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.

D. Copper Pressure Fittings:
   2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

E. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
   1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

F. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.6 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
   1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
   2. Unshielded, Nonpressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
         2) Fernco Inc.
         3) Mission Rubber Company, LLC; a division of MCP Industries.
      c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
d. End Connections: Same size as and compatible with pipes to be joined.
e. Sleeve Materials:


3. Shielded, Non-pressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

2) Mission Rubber Company, LLC; a division of MCP Industries.


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

d. End Connections: Same size as and compatible with pipes to be joined.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

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

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
   1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of 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.
      a. Straight tees, elbows, and crosses may be used on vent lines.
   3. Do not change direction of flow more than 90 degrees.
   4. 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.

L. 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.

M. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
   1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
   3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
P. Plumbing Specialties:
   1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
      a. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
   2. Install drains in sanitary waste gravity-flow piping.
      a. Comply with requirements for drains specified in Section 221319.13 "Sanitary Drains."

Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

R. Install sleeves for piping penetrations of walls, ceilings, and floors.
   1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

S. Install sleeve seals for piping penetrations of concrete walls and slabs.
   1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors.
   1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION


B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.
   1. Cut threads full and clean using sharp dies.
   2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
      a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
      b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
      c. Do not use pipe sections that have cracked or open welds.
D. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

E. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in ODs.

3.5 HANGER AND SUPPORT INSTALLATION

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 fiberglass pipe hangers for horizontal piping in corrosive environments.
   3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
   4. Vertical Piping: MSS Type 8 or Type 42, clamps.
   5. Install individual, straight, horizontal piping runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
   6. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   7. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 10 feet.

H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 60 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 72 inches with 3/8-inch rod.
3. NPS 2-1/2: 96 inches with 1/2-inch rod.

I. Install supports for vertical copper tubing every 10 feet.

J. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.

3.6 CONNECTIONS

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

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join 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 specified in Section 221319 "Sanitary Waste Piping Specialties."
6. Comply with the requirements for floor drains specified in Section 221319.13 “Sanitary Drain”.
7. Equipment: Connect waste piping as indicated.
   a. Provide union for each connection.
   b. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:

1. Sewage Pump: To sewage pump discharge and/or site force main piping.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
F. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 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."

3.8 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 according to 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.
   a. If testing is performed in segments, submit separate report for each test, complete with 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-foot head of water.
b. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspection is visual inspection of all fittings within the system being tested.

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.

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.

3.9 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 or caps on ends of uncompleted piping at end of day and when work stops.

D. Repair damage to adjacent materials caused by waste and vent piping installation.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping including grease waste, NPS 4 and smaller shall be any of the following:

   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; CISPI or heavy-duty hubless-piping couplings; and coupled joints.
   3. Copper Type DWV tube, copper drainage fittings, and soldered joints.

C. Aboveground, vent piping NPS 4 and smaller shall be any of the following:

   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
   3. Copper Type DWV tube, copper drainage fittings, and soldered joints.

D. Underground, soil, waste, and vent piping Including Grease waste. NPS 6 and smaller shall be any of the following:

1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

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. Cleanouts.
      3. Vent Extensions.

   B. Related Requirements:

      1. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.3 DEFINITIONS


   B. PVC: Polyvinyl chloride.

1.4 ACTION SUBMITTALS

   A. Product Data: For each type of product.

1.5 QUALITY ASSURANCE

   A. Plumbing Code of New York State.

   B. State Education Department Planning Standards.

1.6 CLOSEOUT SUBMITTALS

   A. Operation and Maintenance Data: For sanitary waste piping specialties to include in maintenance manuals.
PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.

2.2 CLEANOUTS

A. Cast-Iron Exposed Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   b. Josam Company.
   c. Tyler Pipe; a subsidiary of McWane Inc.
   d. Watts; a Watts Water Technologies company.
   e. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Exposed Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   b. Josam Company.
   c. Tyler Pipe; a subsidiary of McWane Inc.
   d. Watts; a Watts Water Technologies company.
   e. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M for adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Not required.
7. Outlet Connection: Inside calk.
9. Adjustable Housing Material: Cast iron with threads.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Heavy Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   b. Josam Company.
   c. Tyler Pipe; a subsidiary of McWane Inc.
   d. Watts; a Watts Water Technologies company.
   e. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure Plug:
   a. Brass.
   b. Countersunk or raised head.
   c. Drilled and threaded for cover attachment screw.
   d. Size: Same as or not more than one size smaller than cleanout size.

2.3 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Oatey.
   b. RectorSeal.
   c. Studor, Inc.
2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
3. Housing: Plastic.
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected fixture or branch vent piping.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:
1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564 rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
   a. NPS 2: 4-inch- minimum water seal.
   b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

C. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 75 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers flush with finished wall.

D. Install fixture air-admittance valves on fixture drain piping.

E. Assemble open drain fittings and install with top of hub 2 inches above floor.
F. Install deep-seal traps on floor drains and other waste outlets in buildings without heat or where indicated.

G. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

H. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.

I. Clean plumbing vent piping receiving extensions to ensure that joint surfaces are clean, dry, and free from contamination including dirt, oil, grease, tar and other substances which may inhibit adhesive or sealant performance.

J. Apply adhesive or sealant to plumbing vent piping as appropriate for connection of existing pipe material and plumbing vent extension, install plumbing vent extension to existing piping. Apply adequate adhesive or sealant to achieve secure, rigid installation.

K. Install wood-blocking reinforcement for wall-mounting-type specialties.

L. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections, and prepare test reports.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks using head test as outlined in sanitary drainage piping specifications. Repair leaks and retest until no leaks exist.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319
SECTION 221319.13 - SANITARY DRAINS

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. Floor drains.
   2. Floor Sinks.
   3. Trench Drains

B. DEFINITIONS

C. ABS: Acrylonitrile-butadiene styrene.

D. PP: Polypropylene.

E. PVC: Polyvinyl chloride.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 QUALITY ASSURANCE

A. Plumbing Code of New York State.

B. State Education Department Planning Standards.

PART 2 - PRODUCTS

2.1 DRAIN ASSEMBLIES

A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.
2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains (FD):

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Josam Company.
   c. Watts; a Watts Water Technologies company.
   d. Zurn Industries, LLC.

2. Standard: ASME A112.6.3.

5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Not required.
8. Outlet: Bottom.
11. Sediment Bucket: Required.
12. Top or Strainer Material: Bronze.
14. Top Shape: Round. (Square for ceramic tile applications.)
15. Top Loading Classification: Heavy Duty/ Traffic duty in garage bays.
16. Funnel: Not required.
17. Trap Material: Cast iron.

2.3 SANITARY FLOOR SINKS

A. Cast-Iron Floor Drains (FS):

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Josam Company.
   c. Watts; a Watts Water Technologies company.
   d. Zurn Industries, LLC.

2. Standard: ASME A112.6.3.
3. Pattern: Floor sink.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Not required.
8. Outlet: 4” Bottom, with anti-splash plastic dome
11. Sediment Bucket: Required.
12. Top or Strainer Material: Nickel Bronze.
13. Strainer configuration: 3 /4 or 1/ 2 Partial grate.
15. Top Shape: Square.
16. Top Size: Refer to plumbing drawings
17. Top Loading Classification: Medium Duty.
18. Funnel: Required for high flow applications. (dishwasher)

2.4 POLYESTER RESIN TRENCH DRAINS

A. Floor Trench Drain (FT):

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. ACO Inc.
   c. Josam Company.
   d. Watts; a Watts Water Technologies company.
   e. Zurn Industries, LLC.

2. Standard: ASME A112.6.3.
3. Pattern: Modular, Interlocking, 0.5% Sloped Trench Drain.
5. Body Width: Nominal 8 inches.
7. Anchor Flange: Required.
14. Grate configuration: Full slotted grate with boltless locking system.
15. Top Shape: rectangular.
16. Top Size: 8 inches by 39.37 inches
18. Trap Material: Cast iron.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
3. Set with grates depressed according to the following drainage area radii:
   
a. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
4. Install floor-drain flange, so no leakage occurs between drain and adjoining flooring.
   
a. Maintain integrity of waterproof membranes where penetrated.
5. Install individual traps for floor drains connected to sanitary building drain.

B. Install floor sinks flush with finished floor and directly below equipment discharge. If offset, pipe discharge to center opening.

C. Install trench drains in accordance with Manufacturer’s instructions. flush with sloped finished floor.

1. Finished floor hold-down specified in architectural drawings.
2. Install seals between modular sections and catch basins.
3. Align sections and maintain slopes to low point.
4. Flush and clean drains then insert sediment buckets.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319.13
SECTION 221323 - GREASE WASTE INTERCEPTORS

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. Grease interceptors.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

B. PDI: Plumbing and Drainage Institute

C. GREASE INTERCEPTOR: Elliptical fiberglass (FRP) tank system designed with built-in inlet piping and baffle penetration that introduces wastewater in a tangential laminar flow to reduce disruption of collected grease and solids. Tank system is designed to capture and hold grease and solids to maximize waste retention and optimize Stokes Law separation.
   1. GRAVITY GREASE INTERCEPTOR: Elliptical fiberglass (FRP) interceptor that is certified to meet IAPMO/ANSI Z1001-2007 and applicable sections of the latest editions of the Uniform Plumbing Code or the International Plumbing Code. Interceptor is designed to deliver 100 PPM non-emulsified free-floating oil and grease and 350 PPM Total Suspended Solids effluent quality based on inlet peak fixture flow.
   2. HYDROMECAHNICAL OR PDI CERTIFIED GREASE INTERCEPTOR: Elliptical fiberglass (FRP) interceptor that is certified to meet PDI G-101 Standard rated up to 35 GPM flow.

1.4 ACTION SUBMITTALS

A. Product Data: Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.

B. Shop Drawings: For each type and size of interceptor indicated.
   1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.
1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, based on input from Installers of the items involved:

2. Piping connections. Include size, location, and elevation of each.
3. Interface with underground structures and utility services.

1.6 PROJECT CONDITIONS

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

1. Notify Owner’s representative no fewer than seven days in advance of proposed interruption of service.
2. Do not proceed with interruption of sewer services without Owner's written permission.

PART 2 - PRODUCTS

2.1 GREASE INTERCEPTORS

A. Basis of Design: Fiberglass (FRP) grease interceptor construction, with inlet piping and baffle penetration designed to introduce wastewater in a tangential laminar flow pattern, to be appropriately sized based on anticipated usage and flow rates to meet applicable sanitary sewer discharge limits to the Municipal waste water system.

1. Include access ways, tanks, piping and baffle openings to retain grease, solids, and to permit tangential laminar wastewater flow.
2. Factory installed Schedule 40 PVC cement welded type socket ports, or straight pipe, fitted into interceptor walls for each pipe connection.
3. Accessway Extension Collar:
   a. Fiberglass risers: 24”
4. Accessway Frames and Covers: Round cover with non slip cover finish, gasketed and non vented top design with “Proceptor” lettering cast into cover.
   a. Fiberglass: Pedestrian loading 24” diameter bolted and gasketed.
5. Watertight Flexible Caulking: Sikaflex 255 or Sikaflex 221 or approved alternate to provide watertight seal at extension collar joints.

B. Capacities and Characteristics:
1. Number of Compartments: 2 cells separated by baffle
2. Nominal Unit Volume: 1,000 gallons
3. Grease Retention Capacity: 577 gallons
4. Solids Retention Capacity: 295 gallons
5. Inlet and Outlet Schedule 40 PVC Pipe Size: 4”
6. Vent Pipe Size: 3”
7. Installation Position: Interior, below floor, access way and collar.
8. Options:
   a. 4” Suction port for remote pump-out at building exterior.
   b. Alarm for high oil accumulation. Includes factory installed, hard wired alarm probe to be installed in tank. Alarm wiring to be under floor to hard wired indoor wall mounted panel.
   c. Cast Iron Frame and bolt down Cast Iron Cover.
9. Manufacturers of Equipment to be one of the following:
   b. ZCL – Xerxes
   c. Approved Equal.

2.2 FIBERGLASS ACCESS WAY RISERS
A. Fiberglass accessway extensions: Fiberglass wound pipe.
1. Length: From top of underground tank to underside of access frame at floor.
2. Extension Sections: 0.25 inch minimum thickness and 24 inch I.D. as a single continuous piece, without joints.
   a. Sealant: Watertight Flexible Caulking, Sikaflex 255 or Sikaflex 221 or approved alternate to provide watertight seal at extension collar joining to tank on bottom and access frame at top.

2.3 GREASE MONITOR AND ALARM
A. Grease level probe and monitor.
1. Grease level probe to be located in tank by manufacturer. Probe to be explosion proof or supplies with an intrinsic barrier. Probe to be serviceable from the access way. Wiring to be routed below floor to alarm station.
2. Remote alarm station have audio/visual signal with silence override.
3. The probe is to be factory set and ready for field calibration.

PART 3 - EXECUTION

3.1 EARTHWORK
A. Excavating, trenching, and backfilling are specified Project Manual
3.2 INSTALLATION

A. Install FRP interceptors according to ASTM C 581. Set level and plumb.

B. Provide ANTI-BUOYANCY slab as install FRP interceptor per manufacturers recommended installation procedures.
   1. A 6" layer of pea gravel (or approved equivalent backfill compacted to 98% S.P.D.) must be installed and leveled at the bottom of the excavation to the proper elevation for the installation of the separator base.
   2. Install and level the tank on the backfill. Use metal lifting lugs on upper sides of tank for handling, if equipped. Do not use any of the pipe fittings on the tank for lifting purposes. When lifting with slings, use load level beams.
   3. The contractor must fill the separator with water to the recommended weight of the buoyancy slab as indicated on the installation procedure drawing from the manufacturer prior to pouring concrete around the unit.
   4. Pour concrete ready mix buoyancy slab all around the separator cells to the weight shown on the installation procedure drawing. Ensure that the anchor brackets (if equipped) on the side of the tank are covered.

C. Provide granular backfill to the inlet and outlet pipes.
   1. Pea Gravel must be placed in uniform layers of 6" to not more than 8" depth up to the bedding for the inlet and outlet pipes.

D. Install fiberglass extension collars from top of underground interceptors to cover and frame at finished floor per manufacturers recommendation. Extension collar to be bonded to interceptor during installation using SikaFlex 255 FC or 221. Use of substitute bonding material or non-FRP materials for the extension collar may jeopardize this seal, potentially resulting in water infiltration or waste exfiltration from the system. Extension collar height shall be field verified, and a single continuous length used for structural integrity.

E. Backfill to the surface relieving slab.
   1. Pea gravel (or an approved equivalent backfill compacted to 98% SPD in each layer) must be placed around the extension collar to the bottom of the concrete bearing slab in 6" layers thick.

F. Set tops of frame and cover flush with finished floor.
   1. Leave a gap between frame and top of extension collar of approximately 1” to prevent vertical load transfer from the frame to the tank. Seal between collar and frame with flexible watertight material.

G. Reinforcing of floor Slab
   1. Pour concrete slab, 3600 psi, at the surface with traffic loading frame and cover embedded in slab and centered over extension collar to secure the frame and transfer live loads to the surrounding soil around the tank. Pour the concrete slab in place with steel reinforcing bars as shown on manufacturers installation drawings.
   2. Slab designs for design basis interceptor are available from interceptor manufacturer. The contractor must verify that the concrete relieving slab design is suitable for the application and conforms to local codes and standards.
3.3 CONNECTIONS
   A. Piping installation requirements are specified in the drawings and Sanitary Waste and Vent Piping specifications.
   B. Make piping connections between interceptors and piping systems.
   C. Identify vent riser points and verify that vent piping will be clear of kitchen equipment.

3.4 IDENTIFICATION
   A. Identification materials and installation are specified in project manual.

3.5 SET-UP.
   A. Set up level controls and perform testing on level device.
   B. Field calibrate level probe to confirm proper operation.
   C. Program alarm unit to signal when grease interceptor is full.
   D. Adjust delay timer to avoid false signals.

END OF SECTION 221323
SECTION 221413 - FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Hubless, cast-iron soil pipe and fittings.

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS
   A. Coordination Drawings: Detail storm drainage piping. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, and coordinated with each other, using input from installers of the items involved.
   B. Field quality-control reports.

1.4 QUALITY ASSURANCE
   A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
      1. Storm Drainage Piping: 10-foot head of water.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. AB & I Foundry; a part of the McWane family of companies.
      2. Charlotte Pipe and Foundry Company.
      3. Tyler Pipe; a part of McWane family of companies.
B. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Standard: ASTM A 888 or CISPI 301.

C. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ANACO-Husky.
   b. Charlotte Pipe and Foundry Company.
   c. Fernco Inc.
   d. MIFAB, Inc.
   e. Tyler Pipe; a subsidiary of McWane Inc.

2. Couplings shall bear CISPI collective trademark and NSF certification mark.
4. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ANACO-Husky.
   b. Charlotte Pipe and Foundry Company.
   c. Tyler Pipe; a subsidiary of McWane Inc.

3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 SPECIALTY PIPE FITTINGS

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

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 from 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 at indicated slopes.

F. Install piping free of sags and bends.

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

H. Install piping to allow application of insulation.

I. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.
   1. Do not change direction of flow more than 90 degrees.
   2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
      a. Reducing size of drainage piping in direction of flow is prohibited.

J. Install piping at the following minimum slopes unless otherwise indicated:
   1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Storm Drainage Piping: 2 percent downward in direction of flow.


L. Plumbing Specialties:
   1. Install cleanouts every 3rd change in direction connect to building storm drain piping system.
      a. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."
   2. Install drains in storm drainage gravity-flow piping.
      a. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."

M. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

N. Install sleeves for piping penetrations of walls, ceilings, and floors.
1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

3.2 JOINT CONSTRUCTION

A. Hubless, Cast-Iron Soil Piping Coupled Joints:

B. 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 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 and larger, upstream and downstream of all changes in direction 45 degrees and greater.
      c. Provide rigid sway bracing for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction and branch openings.

3.3 HANGER AND SUPPORT INSTALLATION

A. 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 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
   7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting[, valve,] and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

3.4 CONNECTIONS

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

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.

D. Where installing piping adjacent to equipment, allow space for service and maintenance.

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.5 IDENTIFICATION

A. Identify exposed storm drainage piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.6 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.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Test storm drainage piping according to 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.
   a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved.
   a. Expose work that was covered or concealed before it was tested.
3. Test Procedure:
   a. Test storm drainage piping, except outside leaders, on completion of roughing-in.
   b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

C. Piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains 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.

3.8 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty, hubless-piping couplings; and coupled joints.

END OF SECTION 221413.
SECTION 221513 - GENERAL-SERVICE COMPRESSED-AIR PIPING

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 piping and related specialties for general-service compressed-air systems operating at 150 psig or less.

1.3 DEFINITIONS
   A. Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 150 psig or less.

1.4 ACTION SUBMITTALS
   A. Product Data: For the following:

1.5 INFORMATIONAL SUBMITTALS
   A. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For general-service compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE
   A. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or to AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
   B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
C. ASME Compliance:


1.8 PROJECT CONDITIONS

A. Interruption of Existing Compressed-Air Service: Do not interrupt compressed-air service to facilities occupied by Owner unless permitted under the following conditions and then only after arranging to provide temporary compressed-air service according to requirements indicated:

1. Notify Owner no fewer than 5 days in advance of proposed interruption of compressed-air service.
2. Do not proceed with interruption of compressed-air service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Schedule 40, Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B, black pipe, threaded fittings. Minimize threaded connections by using full lengths of pipe. Couplings will be allowed where distance between branches is greater than 20 feet. Threaded fittings to be provided according to ASME B1.20.1.


B. Proprietary Fittings for steel Pipe: Proprietary pipe fittings may be substituted where noted on drawings to reduce building shut-downs.

1. Steel compression/ swaged couplings and flange adapters, complying with ASME B31.8 for Schedule 40 carbon steel pipe.
2. System to be electrically bonded across the joint.
3. Steel compression/ swaged pipe fittings to be Lokring ® or approved equal.

2.2 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for compressed-air piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2.3 VALVES

A. Metal Ball and Check, Valves: Comply with requirements in Section 220523 "General-Duty Valves for Plumbing Piping."

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Compressed-Air Piping for Air Compressor discharge and utility piping: Use the following piping materials for each size range:

1. NPS 2 and Smaller: Schedule 40, black-steel pipe; threaded malleable iron fittings. Keep threaded joints to a minimum by using full lengths of pipe.
2. Couplings will be allowed on straight lengths of pipe that exceed 20 feet.

B. Drain Piping: Use the following piping materials:

1. NPS 2 and Smaller: Type L copper tube; wrought-copper fittings; and soldered joints. Refer to “Section 221116 Domestic Water Piping”.

3.2 VALVE APPLICATIONS

A. General-Duty Valves: Comply with requirements in Section 220523 "General-Duty Valves for Plumbing Piping" for metal general-duty valves. Use metal valves, unless otherwise indicated.

1. Metal General-Duty Valves: Use valve types specified in "Valve Applications" Article in Section 220523 "General-Duty Valves for Plumbing Piping" according to the following:

   a. Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.
   b. Equipment Isolation NPS 2 and Smaller: Copper-alloy ball valve with pressure rating at least as great as piping system operating pressure.
   c. Drain Isolation NPS 2 and Smaller: Copper-alloy ball valve with pressure rating at least as great as piping system operating pressure.
   d. Drain Check Valves NPS 2 and smaller: Copper-alloy swing check valve with pressure rating at least as great as piping system operating pressure.
3.3 PIPING INSTALLATION

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

B. Install piping in exposed locations but close to walls and ceilings. Do not encroach on high bay spaces in areas of vehicle lifts or other high bay operations.

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 otherwise indicated.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.

E. Install piping adjacent to equipment and machines to allow service, maintenance and equipment removal.

F. Install air and drain piping with 1 percent slope downward in direction of flow.

G. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating, unless otherwise indicated.

H. Flanged joints may be used instead of specified joint or union for any piping or tubing system.

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 piping to permit access to valves.

L. Install piping free of sags and bends.

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

N. Install sleeves for piping penetrations of walls, ceilings, and floors.

O. Install sleeve seals for piping penetrations of concrete walls and slabs.

P. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.4 JOINT CONSTRUCTION

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 pipe and fittings before assembly.
C. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

D. Dissimilar Metal Piping Material Joints: Use dielectric fittings and dielectric flange kits.

E. Proprietary pipe joining systems shall be installed in accordance with manufacturers instructions for preparation, installation and inspection, using only approved fixtures and tooling for approved for use with the proprietary fittings.

3.5 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Section 220523 "General-Duty Valves for Plumbing Piping."

B. Install shutoff valves and unions or flanged joints at compressed-air piping to air compressors.

C. Install shutoff valve at inlet to each automatic drain valve, filter, lubricator, and pressure regulator.

D. Install check valves to maintain correct direction of compressed-air flow to and from compressed-air piping specialties and equipment.

3.6 DIELECTRIC FITTING INSTALLATION

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

B. NPS 2 and Smaller: Use dielectric unions.

3.7 CONNECTIONS

A. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.

3.8 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

3.9 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."
3.10 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 above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

2. Repair leaks and retest until no leaks exist.

C. Prepare test reports.

END OF SECTION 221513
SECTION 221519 - GENERAL-SERVICE PACKAGED AIR COMPRESSORS 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. Lubricated, reciprocating air compressors.
   2. Air-cooled, compressed-air aftercoolers.
   3. Refrigerated compressed-air dryers.
   4. Coalescing and Particulate Filters
   5. Point of use Filter/ Regulators.

1.3 DEFINITIONS

A. Actual Air: Air delivered from air compressors. Flow rate is delivered compressed air measured in acfm.

B. Standard Air: Free air at 68 deg F and 1 atmosphere before compression or expansion and measured in scfm.

1.4 COMPLIANCE

A. Compressed air equipment to be in compliance the following:
   1. NFPA 70
   2. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1

1.5 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 diagrams for power, signal, and control wiring.
C. Delegated-Design Submittal: For compressed-air equipment mounting.
   1. Detail fabrication and assembly of supports.
   2. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

1.6 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For compressed-air equipment, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For compressed-air equipment to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Air-Compressor, Inlet-Air-Filter Elements: Provide 2 replacement elements for each element installed.
   2. Belts: Two replacements for each installed belt.

1.9 FIELD CONDITIONS

A. Interruption of Existing Compressed-Air 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 Owner no fewer than two days in advance of proposed interruption of compressed-air service.
   2. Do not proceed with interruption of compressed-air service without Owner’s written permission.

1.10 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.
PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

2.2 GENERAL REQUIREMENTS FOR PACKAGED AIR COMPRESSORS AND EQUIPMENT

A. General Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.

B. Control Panels: Automatic Pressure control switch with adjustable set point.

1. Enclosure: NEMA 1 unless otherwise indicated.
3. Control Voltage: 120-V ac or less, using integral control power transformer.
7. Adjustable pressure switch for air compressor.
8. Accessories: Air-filter maintenance indicators where manual drain is provided, Control transformer.

C. Air Compressor: Two stage reciprocating compressor head with air cooled intercooler and after cooler.

D. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1. Pressure Rating: At least as high as highest discharge pressure of connected compressors, and bearing appropriate code symbols.
2. Interior Finish: Corrosion-resistant coating.
3. Accessories: Include safety relief valve, pressure gage, automatic drain.

E. Mounting Frame: Fabricate mounting and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.

2.3 RECIPROCATING AIR COMPRESSOR

A. Reciprocating Air Compressor: Tank mounted air compressor with belt driven air cooled two stage compressor:
1. Ingersoll Rand
2. Gardener Denver
3. Champion.

B. Characteristics:

1. Standard-Air Capacity: See Air Compressor Schedule.
2. Intake-Air Temperature: Ambient 50 – 90 deg. F.
4. Electrical Characteristics:
   b. Phase(s): Three.
   c. Hertz: 60.
5. Receiver: ASME construction steel tank.
   a. Arrangement: Horizontal.
   b. Capacity: See Air Compressor Schedule.
   c. Interior Finish: Epoxy coating.
   d. Operating Pressure: 150 psig.
   e. Pressure Rating: 175 psig minimum.
   f. Pressure Relief Valve Setting: 165 psig.
   g. Drain: Automatic valve.

2.4 REFRIGERATED COMPRESSED-AIR DRYERS
1. Ingersoll Rand
2. Gardener Denver
3. Sullair.

B. Description: Non-cycling, air-cooled, electric-motor-driven unit with steel enclosure and capability to deliver 35 deg F, 150-psig air at dew point. Include automatic ejection of condensate from airstream, disconnect switch, inlet and outlet pressure gages, thermometers, automatic controls, and filters.

C. Capacities and Characteristics:

2. Pressure: 150 psig.
3. Entering-Air Temperature: Ambient 50 – 90 deg. F.
4. Electrical Characteristics:
   a. Volts: 120.
   b. Phase(s): Single.
   c. Hertz: 60.

2.5 COMPRESSED AIR FILTERS
1. Ingersoll Rand
2. Gardener Denver
3. Sullair.

B. Description: Filter housings and elements with automatic drains for coalescing filters and particulate filters.

C. Point of use filter/ regulators with adjustable pressure settings and manual drain.
   1. Norgren USA.
   2. Approved Equal.

2.6 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."

   1. Enclosure: Totally enclosed air over ventilation.
   2. Motor Sizes: Minimum size as indicated.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Equipment Mounting:
   1. Install air compressors, aftercoolers, and air dryers on cast-in-place concrete equipment base(s) for floor mounting and on steel supports for elevated equipment.
   2. Provide vibration isolation pads for all rotating equipment.

B. Install compressed-air equipment anchored to substrate.

C. Arrange equipment so controls and devices are accessible for servicing.

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Install the following devices on compressed-air equipment:
   1. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.
   2. Pressure Regulators: Install downstream from air compressors.

3.2 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 machine, allow space for service and maintenance.

3.3 IDENTIFICATION

A. Identify general-service air compressors and components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check for lubricating oil in lubricated-type equipment.
3. Check belt drives for proper tension.
4. Verify that air-compressor inlet filters and piping are clear.
5. Check for equipment vibration-control supports and flexible pipe connectors, and verify that equipment is properly attached to substrate.
6. Check safety valves for correct settings. Ensure that settings are higher than air-compressor discharge pressure, but not higher than rating of system components.
7. Drain receiver tanks.
8. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
9. Test and adjust controls and safeties.

3.5 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 221519
SECTION 223300 - ELECTRIC, INSTANTANEOUS DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Commercial, light-duty, instantaneous, electric, domestic-water heaters.
   2. Domestic-water heater accessories.

1.2 REFERENCES

A. General: Applicable edition of references cited in this Section is current edition published on date of issue of Project specifications, unless otherwise required by building code in force.

B. American National Standards Institute (ANSI)
   1. ANSI 372 – Drinking Water System Components – Lead Content

C. American Society of Sanitary Engineering (ASSE):

D. ASSE 1010 - Performance Requirements for Water Hammer Arresters

E. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code

F. NSF International
   1. NSF 61 - Drinking Water System Components – Health Effects
   2. NSF 372 - Drinking Water System Components - Lead Content

G. Underwriters Laboratories (UL):
   1. UL 499 - Standard for Electric Heating Appliances

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of instantaneous domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:
1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS
A. Product Certificates: For each type of commercial, electric, instantaneous domestic-water heater, from manufacturer.
B. Source quality-control reports.
C. Field quality-control reports.
D. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For electric, instantaneous domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
C. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.7 COORDINATION
A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.8 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-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.

2. Warranty Periods: From date of Substantial Completion.
   a. Commercial, Light-Duty, Electric, Instantaneous Domestic-Water Heaters:
1) Controls and Other Components: Three years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide electric tankless commercial water heaters by one of the following:

1. EEMAX
2. Hubble
3. Rheem
4. Approved Equal

2.2 ELECTRIC, INSTANTANEOUS DOMESTIC WATER HEATERS

A. Electric instantaneous domestic water heater, UL 499, sized for low flow constant temperature requirements, with PID Controller, low flow activation, and overheat protection.

B. Characteristics:

1. Internal Coating: FDA approved for domestic drinking water contact
4. Heating Element: Heavy duty electric resistive element.
5. Temperature Control: Microprocessor with PID logic and dual display of set-point and actual outlet water temperature.
6. Safety Controls:
   a. Surface mounted bi-metal thermostat with manual reset.
8. Capacity: See Schedules

2.3 WATER HEATER ACCESSORIES

A. Provide electric tankless water heater system including the following system accessories:


PART 3 - EXECUTION

3.1 INSTANTANEOUS DOMESTIC-WATER HEATER INSTALLATION

A. Light Commercial, Electric, instantaneous Domestic-Water Heater Mounting: Install equipment on wall bracket.

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Anchor domestic-water heaters to substrate.

B. Install equipment level and plumb, according to 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 instantaneous domestic-water heaters.

C. Flush electric, instantaneous domestic-water heaters with water.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

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

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
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 operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 223300
PART 1 - GENERAL

1.1 SUMMARY

A. Scope: This work shall consist of furnishing and installing a stationary high pressure washer and accessories in accordance with the details shown on the plans and these special provisions.

1.2 COMPLIANCE

A. Pressure washer equipment is to be ETL listed and in compliance with UL-1776, Standard for High-Pressure Cleaning Machines.

1.3 SUBMITTALS

A. Product Data:

1. Manufacturer's descriptive data for high pressure washer shall be submitted for approval.

2. Manufacturer's descriptive data shall include name and address, complete description, performance data and installation instructions for the materials and accessories specified herein.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Manuals: Prior to the completion of the contract, 3 identified copies of the operation and maintenance instructions with parts lists for the equipment specified herein shall be delivered to the Owner at the close of the Project. The instructions and parts lists shall be in a bound manual form and shall be complete and adequate for the equipment installed. Inadequate or incomplete material shall be returned. The Contractor shall resubmit adequate and complete manuals at no expense to the Owner.

1.5 WARRANTY

A. Warranties and Guarantees: Manufacturers warranties and guarantees for materials or equipment used in the work shall be delivered to the Owner at the close of the Project.

B. The Warranty period will begin when the Owner accepts the equipment as operational. The Warranty for the unit is to be a period of not less than 1 year. The coil Warranty is to be for a period of 5 years and 7 years for the pump.
2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with the requirements, products shall be:
   1. Liberty Karcher,
   2. Hotsey,
   3. Whitco,
   4. Approved equal.

2.2 MANUFACTURED UNITS

A. High Pressure Washer:
   1. High pressure washer shall be stationary type, electric motor driven, natural gas-fired, minimum 80 percent efficient, automatic operating type washer designed for continuous operation. The washer shall have a capacity of 240 GPH of hot water solution heated to 135 °F at 2,200 psi. Maximum natural gas input shall be 364,000 BTU/Hour. The heating coil shall have an inside diameter of not less than ½ inch. The unit shall be completely housed in a steel cabinet with parts shielded from spray or splash. Heating unit shall be have adjustable heat setting up to 135 °F.
   2. Washer unit shall be equipped with an on/off pump motor and washer heater switch control panel. All controls including remote operator shall be 24 volt AC. The motor shall be as identified in the schedules and plans.
   3. The control panel shall display temperature and pressure gauges and shall include the motor starter and the power disconnect breaker.
   4. The unit shall be equipped with safety controls, safety valve, pressure unloader, vent stack, draft hood and the following accessories: swivel cleaning gun with trigger control and 30-inch long extension; 3/8-inch high pressure hose rated for 3,500 psi at 250°F; spray nozzles to allow flat, round and wide angle spray patterns at full flow at 2,200 psi; water pump and regulator; and wall mounted hose reel and wand holder.

2.3 ACCESSORIES

A. Pressure Washer Hose, Wand, pipe and Fittings: Pressure accessories to be rated for maximum allowable working pressure and temperature.

B. Vent Stack: Vent stack shall be listed Class B. Vent stack shall include back draft diverter, fire stop spacer, ventilating thimble with drip cap and listed vent cap.

C. The unit is to be provided with the following accessories:
   1. (2) 3/8”, 50 foot hoses.
   2. (1) Hand Wand with replaceable nozzles.
   3. Gauge Assembly
   4. Filter housing, mounting bracket and 20 micron element.
   5. Wall mount, 100 foot pivot reel.
6. Unloader with switch.

PART 3 – EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Equipment Mounting.
   1. Install equipment on cast in place concrete pad for floor mounting. Pad to be nominal 4” in height with chamfered edges. Provide (1) #4 perimeter reinforcement bar and pin to the existing floor.
   2. Scarify the existing floor to allow bond with concrete pad.
   3. Pitch surface of pad 1/8” per foot away from walls to drain.
   4. Provide vibration isolation pads for rotating equipment.
   5. Install equipment in accordance with manufacturer’s instructions.

B. Install equipment anchored to substrate.

C. Arrange equipment so controls and devices are accessible for servicing.

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Hose reel shall be attached to the wall with 3/8-inch (minimum) stud type expansion anchors. A wand holder shall be supplied to hold the gun assembly. Wand holder shall be attached to the wall with expansion anchors.

3.2 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check for lubricating oil in lubricated-type equipment.
   3. Check belt drives for proper tension.
   4. Verify that Pressure Washer inlet filters and piping are clear.
   5. Check for equipment vibration-control supports and flexible pipe connectors, and verify that equipment is properly attached to substrate.
   6. Check safety valves for correct settings. Ensure that settings are higher than pressure washer discharge pressure, but not higher than rating of system components.
   7. Check burner operation and set outlet temperature. Temp to be less than 135°F.
   8. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   9. Test and adjust controls and safeties.

3.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air compressors and air dryers.
SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC 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 general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 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 GENERAL MOTOR REQUIREMENTS
   A. Comply with NEMA MG 1 unless otherwise indicated.
   B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS
   A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
   B. 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.
2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. 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.

B. Motors Used with Variable Frequency Controllers:
   1. 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.
   2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.
2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.
   2. Split phase.
   3. Capacitor start, inductor run.
   4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. 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 shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513
SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

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. Sleeves.
      2. Sleeve-seal fittings.
      4. Silicone sealants.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Related Requirements:
      1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-
         resistance-rated walls, horizontal assemblies, and smoke barriers, with and without
         penetrating items.

1.4 INFORMATIONAL SUBMITTALS
   A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES
   A. Manufacturers: Subject to compliance with requirements, available manufacturers offering
      products that may be incorporated into the Work include, but are not limited to the following:
      1. Advance Products & Systems, Inc.
      2. CALPICO, Inc.
      3. GPT; an EnPro Industries company.
B. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.

C. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends and integral welded waterstop collar.

D. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

E. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.

F. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

G. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.2 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.

B. Description:

1. Manufactured plastic, sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.
2. Plastic or rubber waterstop collar with center opening to match piping OD.

2.3 GROUT

A. Description: Nonshrink, recommended for interior and exterior sealing openings in nonfire-rated walls or floors.


C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, use NT.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Dow Corning Corporation.
   b. GE Construction Sealants; Momentive Performance Materials Inc.
   c. Sherwin-Williams Company (The).

B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.

C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

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 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. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. 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 above finished floor level.
3. Using grout or silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.

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 annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use sealants 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."

3.2 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings 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 to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout or silicone sealant, seal space around outside of sleeve-seal fittings.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. 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.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls Above Grade:
   a. Piping Smaller Than NPS 6: Cast-iron sleeves.

2. Interior Partitions:
   a. Piping Smaller Than NPS 6: Steel pipe sleeves.

END OF SECTION 230517
SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

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. Escutcheons.
      2. Floor plates.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS
   A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.
   B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
   C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
   D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.
   E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES
   A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
   B. Split-Casting Floor Plates: Cast brass with concealed hinge.
PART 3 - EXECUTION

3.1 INSTALLATION

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 piping and with OD that completely covers opening.

1. Escutcheons for New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Insulated Piping: One-piece, stamped-steel type.
   c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with finish.
   f. Bare Piping in Equipment Rooms: One-piece, cast-brass type with finish.

2. Escutcheons for Existing Piping:
   a. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
   b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
   c. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
   d. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated finish.
   e. Bare Piping in Equipment Rooms: Split-casting brass type with polished, chrome-plated finish.

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: One-piece, floor-plate type.
   2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 230518
SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

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. Liquid-in-glass thermometers.
   2. Thermowells.
   3. Dial-type pressure gages.
   4. Gage attachments.
   5. Test plugs.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   
a. Flo Fab Inc.
b. Miljoco Corporation.
d. Tel-Tru Manufacturing Company.
e. Trerice, H. O. Co.
f. Weiss Instruments, Inc.
g. Winters Instruments - U.S.

2. **Standard:** ASME B40.200.
3. **Case:** Cast aluminum; 7-inch nominal size unless otherwise indicated.
4. **Case Form:** Adjustable angle unless otherwise indicated.
5. **Tube:** Glass with magnifying lens and blue or red organic liquid.
6. **Tube Background:** Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. **Window:** Glass.
8. **Stem:** Aluminum and of length to suit installation.
   a. **Design for Thermowell Installation:** Bare stem.
9. **Connector:** 1-1/4 inches, with ASME B1.1 screw threads.
10. **Accuracy:** Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

### 2.2 THERMOWELLS

**A. Thermowells:**

1. **Standard:** ASME B40.200.
2. **Description:** Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. **Material for Use with Copper Tubing:** CNR or CUNI.
4. **Material for Use with Steel Piping:** CRES or CSA.
5. **Type:** Stepped shank unless straight or tapered shank is indicated.
6. **External Threads:** NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. **Internal Threads:** 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. **Bore:** Diameter required to match thermometer bulb or stem.
9. **Insertion Length:** Length required to match thermometer bulb or stem.
10. **Lagging Extension:** Include on thermowells for insulated piping and tubing.
11. **Bushings:** For converting size of thermowell's internal screw thread to size of thermometer connection.

**B. Heat-Transfer Medium:** Mixture of graphite and glycerin.

### 2.3 DIAL-TYPE PRESSURE GAGES

**A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:**
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. AMETEK, Inc.; U.S. Gauge.
   b. Ashcroft Inc.
   c. Ernst Flow Industries.
   d. Flo Fab Inc.
   e. Marsh Bellofram.
   f. Miljoco Corporation.
   g. Noshok.
   h. Palmer Wahl Instrumentation Group.
   i. REOTEMP Instrument Corporation.
   j. Tel-Tru Manufacturing Company.
   k. Trerice, H. O. Co.
   l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   m. Weiss Instruments, Inc.
   n. Winters Instruments - U.S.

3. Case: Sealed type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   1. Flow Design, Inc.
   2. Peterson Equipment Co., Inc.
   3. Trerice, H. O. Co.
   4. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   5. Weiss Instruments, Inc.
B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

PART 3 - EXECUTION

3.1 INSTALLATION

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 direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids (except steam).

H. Install test plugs in piping tees.

I. Install connection fittings in accessible locations for attachment to portable indicators.

J. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic coil in air-handling units.
3. Outside-, return-, supply-, and mixed-air ducts.

K. Install pressure gages in the following locations:

1. Discharge of each pressure-reducing valve.
3.2 CONNECTIONS
   A. Install meters and gages adjacent to machines and equipment to allow space for service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING
   A. After installation, calibrate meters according to manufacturer's written instructions.
   B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE
   A. Thermometers at inlet and outlet of each hydronic zone shall be one of the following:
      1. Industrial-style, liquid-in-glass type.
      2. Test plug with EPDM self-sealing rubber inserts.
   B. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one of the following:
      1. Industrial-style, liquid-in-glass type.
      2. Test plug with EPDM self-sealing rubber inserts.
   C. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be one of the following:
      1. Industrial-style, liquid-in-glass type.
   D. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE
   A. Scale Range for Heating, Hot-Water Piping: 20 to 240 deg F.

3.6 PRESSURE-GAGE SCHEDULE
   A. Pressure gages at discharge of each pressure-reducing valve shall be one of the following:
      1. Liquid-filled Sealed, direct-mounted, metal case.
      2. Test plug with EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE
   A. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi.

END OF SECTION 230519
SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

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. Bronze ball valves.
      2. Bronze swing check valves.
   B. Related Sections:
      1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
      2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS
   A. CWP: Cold working pressure.
   B. EPDM: Ethylene propylene copolymer rubber.
   C. NRS: Nonrising stem.
   D. RS: Rising stem.

1.4 SUBMITTALS
   A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE
   A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
   B. ASME Compliance:
      1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
4. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. American Valve, Inc.
   b. Conbraco Industries, Inc.; Apollo Valves.
   c. Crane Co.; Crane Valve Group; Crane Valves.
   d. Hammond Valve.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2.2 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.5 for pipe flanges and flanged fittings, NPS 1/2 through NPS 24.
2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. Refer to HVAC valve schedule articles for applications of valves.

E. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:
   1. Handwheel: For valves other than quarter-turn types.
   2. Handlever: For quarter-turn valves NPS 6 and smaller.

H. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
   1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

I. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves.
   2. Solder Joint: With sockets according to ASME B16.18.
   3. Threaded: With threads according to ASME B1.20.1.

J. Valve Bypass and Drain Connections: MSS SP-45.

2.3 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
   1. Description:
      b. SWP Rating: 150 psig.
      c. CWP Rating: 600 psig.
      d. Body Design: Two piece.
      e. Body Material: Bronze.
      f. Ends: Threaded.
      g. Seats: PTFE or TFE.
      h. Stem: Bronze.
      i. Ball: Chrome-plated brass.
      j. Port: Full.

2.4 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:
   1. Description:
      a. Standard: MSS SP-80, Type 3.
      b. CWP Rating: 200 psig.
      c. Body Design: Horizontal flow.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

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

B. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

F. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.
3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball valve.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends.

3.5 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Ball Valves: Two piece, full port, bronze with bronze trim.
   2. Bronze Swing Check Valves: Class 125, bronze or nonmetallic disc.

END OF SECTION 230523
SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following hangers and supports for HVAC system piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal Framing Systems
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe stands.
   7. Equipment supports

B. Related Sections include the following:
   1. Section 230548 "Vibration and Seismic Controls for HVAC" for vibration isolation devices.

1.3 DEFINITIONS

A. MSS: Manufactures Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

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

1.5 SUBMITTALS

A. Product Data: For the following:
1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Pipe stands.
6. Equipment supports.

PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS AND SUPPORTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
   a. AAA Technology & Specialties Co., Inc.
   b. Bergen-Power Pipe Supports.
   c. B-Line Systems, Inc.; a division of Cooper Industries.
   d. Carpenter & Paterson, Inc.
   e. Empire Industries, Inc.
   f. ERICO/Michigan Hanger Co.

B. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

C. Copper Pipe 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

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, 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.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

   b. Flex-Strut, Inc.
   c. G-Strut
   d. Haydon Corp.
   e. Powerstrut Corm.
   f. Unistrut Corp.
   g. Wesanco, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.


4. Channels: Continuous slotted steel channel with inturned lips.

5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.


2.4 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig-minimum. compressive-strength insulation insert encased in sheet metal shield.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

   a. Carpenter & Paterson, Inc.
   b. ERICO/Michigan Hanger Co.
   c. PHS Industries, Inc.
   d. Pipe Shields, Inc.
   e. Rilco Manufacturing Company, Inc.
   f. Value Engineered Products, Inc.

B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

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

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

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.
2.5 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.

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

2.6 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: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

D. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

E. 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.

2.7 EQUIPMENT SUPPORTS

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

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in

B. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

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

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

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

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

D. 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.

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

F. 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.

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

H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
I. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Do not exceed pipe stress limits according to ASME B31.1 for power piping and 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.

3. 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.

4. Insert Material: Length at least as long as protective shield.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

J. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. 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 A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

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

L. 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.


3.3 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.

3.4 PAINTING

A. Touch Up: 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.

1. Apply paint by brush or spray to provide 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 A 780.

3.5 HANGER AND SUPPORT SCHEDULE

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

B. Comply with MSS SP-69 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 metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and copper 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. 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.

3. 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.

4. 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.

5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
11. 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 might occur.
12. 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 might occur.
13. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
14. 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 might occur and vertical adjustment is not necessary.
15. 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 might be required in addition to expansion and contraction.

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 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.

END OF SECTION 230529
SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

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. Restrained Elastomeric Isolation Mounts
   2. Restrained Spring Isolators
   3. Resilient pipe guides.
   4. Elastomeric hangers.
   5. Spring hangers.
   7. Restraint cables.
   8. Seismic-restraint accessories.
   9. Mechanical anchor bolts.
   10. Vibration isolation equipment bases.

1.3 DEFINITIONS

C. OSHPD: Office of Statewide Health Planning & Development (for the State of California).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES or OSHPD.
b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
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.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For testing agency.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: 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 and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:
1. Nominal Wind Speed: 93 mph (3-second gust).
2. Building Occupancy Risk Category: IV.
3. Minimum 10 lb/sq. ft. multiplied by maximum area of HVAC component projected on
   vertical plane normal to wind direction, and 45 degrees either side of normal.

B. Seismic-Restraint Loading:

1. Seismic Design Category as Defined by ASCE: C.
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: See drawings.
   a. Component Importance Factor: 1.5.
   b. SDS: 0.145g as per ASCE 7-10 Section 11.4.4
   c. SD1: 0.087g as per ASCE 7-10 Section 11.4.4

3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 0.136g.
4. Design Spectral Response Acceleration at 1.0-Second Period: 0.054g.
5. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of
   components shall be at least four times the maximum seismic forces to which they are
   subjected.

2.2 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers
   offering products that may be incorporated into the Work include, but are not limited to,
   the following:
   a. Ace Mountings Co., Inc.
   b. Kinetics Noise Control, Inc.
   c. Mason Industries, Inc.
   d. Vibration Isolation.
   e. Vibration Mountings & Controls, Inc.

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. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric
   material.

2.3 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Ace Mountings Co., Inc.
   b. Kinetics Noise Control, Inc.
   c. Mason Industries, Inc.
   d. Vibration Eliminator Co., Inc.
   e. Vibration Isolation.

2. Description: All-directional isolator with seismic 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.

2.4 RESTRAINED-SPRING ISOLATORS


1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Ace Mountings Co., Inc.
   b. Kinetics Noise Control, Inc.
   c. Mason Industries, Inc.
   d. Vibration Eliminator Co., Inc.
   e. Vibration Isolation.

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 psig.
   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.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
2.5 RESILIENT PIPE GUIDES

A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-thick neoprene.

1. 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.

2.6 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. Ace Mountings Co., Inc.
   b. Kinetics Noise Control, Inc.
   c. Mason Industries, Inc.
   d. Vibration Eliminator Co., Inc.
   e. Vibration Mountings & Controls, Inc.

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. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.7 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. Ace Mountings Co., Inc.
   b. Kinetics Noise Control, Inc.
   c. Mason Industries, Inc.
   d. Vibration Eliminator Co., Inc.
   e. Vibration Isolation.
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. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.8 SNUBBERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Kinetics Noise Control, Inc.
2. Mason Industries, Inc.
3. Vibration Mountings & Controls, Inc.

B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch air gap, and minimum 1/4-inch-thick resilient cushion.

2.9 RESTRAINT CABLES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Kinetics Noise Control, Inc.
2. Mason Industries, Inc.
3. Vibration Mountings & Controls, Inc.

B. Restraint Cables: ASTM A 603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.
2.10 SEISMIC-RESTRAINT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. B-line, an Eaton business.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.11 MECHANICAL ANCHOR BOLTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. B-line, an Eaton business.
2. Hilti, Inc.
4. Mason Industries, Inc.

B. Mechanical Anchor Bolts: 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 required for anchor and as tested according to ASTM E 488.

2.12 VIBRATION ISOLATION EQUIPMENT BASES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Kinetics Noise Control, Inc.
2. Mason Industries, Inc.
3. Vibration Eliminator Co., Inc.
4. Vibration Isolation.
B. Steel Rails: Factory-fabricated, welded, structural-steel rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Rails shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

D. Concrete Inertia Base: Factory-fabricated or field-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.13 RESTRAINED ISOLATION ROOF-CURB RAILS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Ace Mountings Co., Inc.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.
4. Thybar Corporation.

B. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.

C. Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces.

D. Lower Support Assembly: The lower support assembly shall be formed sheet metal section containing adjustable and removable steel springs that support the upper frame. The lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.

F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of 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 Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or OSHPD.

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 seismic forces.
C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

B. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

C. Equipment Restraints:
   1. Install seismic 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. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or OSHPD that provides required submittals for component.

D. Piping Restraints:
   1. Comply with requirements in MSS SP-127.
   2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
   3. Brace a change of direction longer than 12 feet.

E. Install cables so they do not bend across edges of adjacent equipment or building structure.

F. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or OSHPD that provides required submittals for component.

G. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

H. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

I. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

J. Drilled-in 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 the structural engineer if reinforcing steel or other embedded items are
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: 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. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 232113 "Hydronic Piping" for piping flexible connections.

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.
   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.
   7. Measure isolator deflection.
   8. Verify snubber minimum clearances.
   9. Test and adjust restrained-air-spring isolator controls and safeties.
D. Remove and replace malfunctioning units and retest as specified above.
E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after piping 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.

END OF SECTION 230548
SECTION 230553 - IDENTIFICATION FOR HVAC 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. Equipment labels.
2. Pipe labels.
3. Duct labels.
4. Stencils.
5. Valve tags.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
C. Valve numbering scheme.
D. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

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.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
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.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.3 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: White.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater
viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

2.4 STENCILS

A. Stencils for Piping:

1. Lettering Size: At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
2. Stencil Material: Aluminum.
3. Stencil and Identification Paint: Exterior, gloss, alkyd enamel in colors indicated. Paint may be in pressurized spray-can form.

B. Stencils for Ducts:

1. Lettering Size: Minimum letter height of 1-1/4 inches for viewing distances up to 15 feet and proportionately larger lettering for greater viewing distances.
2. Stencil Material: Aluminum.
3. Stencil Paint and Identification Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data. Provide schedule in document frame and location at owner’s directions, or update existing valve schedule.
PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION 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.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment. This shall include at a minimum all air handling units, VAV Boxes, split systems and computer room HVAC systems, boilers, and pumps.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.

1. Identification Paint: Use for contrasting background.

B. 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. Near each valve and control device.
2. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

D. Pipe Label Color Schedule:

1. Heating Water Piping:
   a. Background Color: Red.
2. Condensate Drain Water Piping:
   a. Background Color: Blue
   b. Letter Color: White

3. Refrigerant Piping:
   a. Background Color: Safety-purple
   b. Letter Color: White

3.5 DUCT LABEL INSTALLATION

A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts.
2. Yellow: For hot-air supply ducts.

B. Stenciled Duct Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.

C. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape: Round.
2. Valve-Tag Color: Natural.

END OF SECTION 230553
SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

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:

2. Controls Verification

1.3 DEFINITIONS

B. BAS: Building automation systems.
D. TAB: Testing, adjusting, and balancing.
F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
G. TDH: Total dynamic head.

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. Certified TAB reports.

C. Sample report forms.

D. 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 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 as a TAB technician.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.6 FIELD CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. 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, gage 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 system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

F. Examine test reports specified in individual system and equipment Sections.

G. 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.
H. Examine strainers. Verify that startup screens have been replaced by permanent screens with
indicated perforations.

I. Examine control valves for proper installation for their intended function of throttling, diverting,
or mixing fluid flows.

J. Examine operating safety interlocks and controls on HVAC equipment.

K. 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.
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. Automatic temperature-control systems are operational.
   g. Ceilings are installed.
   h. Windows and doors are installed.
   i. Suitable access to balancing devices and equipment is provided.

2. Hydronics:
   a. Verify leakage and pressure tests on water distribution systems have been
      satisfactorily completed.
   b. Piping is complete with terminals installed.
   c. Water treatment is complete.
   d. Systems are flushed, filled, and air purged.
   e. Strainers are pulled and cleaned.
   f. Control valves are functioning per the sequence of operation.
   g. Shutoff and balance valves have been verified to be 100 percent open.
   h. 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 according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

B. Mark equipment and balancing devices, including valve position indicators, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

C. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

D. 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.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling-unit components.

3.5 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 Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

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 Record Documents 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 Construction Manager 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, rpms, 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.
3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps and coils. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
   1. Check liquid level in expansion tank.
   2. Check highest vent for adequate pressure.
   3. Check flow-control valves for proper position.
   4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
   5. Verify that motor starters are equipped with properly sized thermal protection.
   6. Check that air has been purged from the system.

3.7 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Adjust pumps to deliver total design gpm.
   1. Measure total water flow.
      a. Position valves for full flow through coils.
      b. Measure flow by main flow meter, if installed.
      c. If main flow meter is not installed, determine flow by pump TDH pressure drop.
   2. Measure pump TDH as follows:
      a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
      b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
      c. Convert pressure to head and correct for differences in gage heights.
      d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
      e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

B. Adjust flow-measuring devices installed at terminals for each space to design water flows.
   1. Measure flow at terminals.
   2. Adjust each terminal to design flow.
   3. Re-measure each terminal after it is adjusted.
C. Adjust flow-measuring devices installed at terminals for each space to design water flows.
   1. Measure flow at terminals.
   2. Adjust each terminal to design flow.
   3. Re-measure each terminal after it is adjusted.
   4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
   5. Perform temperature tests after flows have been balanced.

D. For systems with pressure-independent valves at terminals:
   1. Measure differential pressure and verify that it is within manufacturer's specified range.
   2. Perform temperature tests after flows have been verified.

E. For systems without pressure-independent valves or flow-measuring devices at terminals:
   1. Measure and balance coils by either coil pressure drop or temperature method.
   2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

F. Verify final system conditions as follows:
   1. Re-measure and confirm that total water flow is within design.
   2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
   3. Mark final settings.

G. Verify that memory stops have been set.

3.8 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:
   1. Verify temperature 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 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 or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.
3.9 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.
   2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
   3. Check the condition of filters.
   4. Check the condition of coils.
   5. Check the operation of the drain pan and condensate-drain trap.
   6. Check bearings and other lubricated parts for proper lubrication.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. 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.

3.10 TOLERANCES

A. Set HVAC system’s airflow rates and water flow rates within the following tolerances:
   1. Heating-Water Flow Rate: Plus or minus 10 percent.

3.11 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 systems
balancing devices. Recommend changes and additions to systems 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.

3.12 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. Manufacturers' test data.
2. Field test reports prepared by system and equipment installers.
3. 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.
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.

D. Test conditions for fans and pump performance forms including the following:
   a. Settings for outdoor-, return-, and exhaust-air dampers.
   b. Conditions of filters.
   c. Face and bypass damper settings at coils.
   d. Settings for supply-air, static-pressure controller.
   e. Other system operating conditions that affect performance.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, 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, and bore.
   i. Center-to-center dimensions of sheave and amount of adjustments in inches.
   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 rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Center-to-center dimensions of sheave and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Filter static-pressure differential in inches wg.
   f. Preheat-coil static-pressure differential in inches wg.
   g. Heating-coil static-pressure differential in inches wg.
   h. Outdoor airflow in cfm.
   i. Return airflow in cfm.
   j. Outdoor-air damper position.
   k. Return-air damper position.

4. Test Data (Indicated and Actual Values):
a. Airflow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Refrigerant expansion valve and refrigerant types.
i. Refrigerant suction pressure in psig.
j. Refrigerant suction temperature in deg F.
k. Inlet steam pressure in psig.

F. 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, and bore.
   h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:
   a. Motor make, and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
   g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Suction static pressure in inches wg.

G. Round, Flat-Oval, 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 and air-handling-unit number.
   b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

3.13 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 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 testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, 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.

2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.

3. If the second verification also fails, Architect may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

END OF SECTION 230593
SECTION 230700 - HVAC INSULATION

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. Insulation Materials:
   a. Mineral fiber.
2. Adhesives.
3. Mastics.
4. Lagging adhesives.
5. Sealants.
6. Factory-applied jackets.
7. Field-applied jackets.
8. Tapes.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings:

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, flanges, valves, and specialties for each type of insulation.
3. Detail removable insulation at piping specialties, equipment connections, and access panels.
4. Detail application of field-applied jackets.
5. Detail application at linkages of control devices.

C. Qualification Data: For qualified Installer.

D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, and jackets, with requirements indicated. Include dates of tests and test methods employed.
E. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and tapes, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation. 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.

1.7 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 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

D. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

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. Aeroflex USA Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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. CertainTeed Corp.; Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Duct Wrap.
   d. Manson Insulation Inc.; Alley Wrap.
   e. Owens Corning; All-Service Duct Wrap.

F. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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. CertainTeed Corp.; Commercial Board.
   b. Fibrex Insulations Inc.; FBX.
   c. Johns Manville; 800 Series Spin-Glas.
   d. Knauf Insulation; Insulation Board.
   e. Manson Insulation Inc.; AK Board.
   f. Owens Corning; Fiberglas 700 Series.

G. Mineral-Fiber, Preformed Pipe Insulation:

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. Fibrex Insulations Inc.; Coreplus 1200.
   b. Johns Manville; Micro-Lok.
   c. Knauf Insulation; 1000 Pipe Insulation.
2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 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.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Aeroflex USA Inc.; Aeroseal.
   b. Armacell LCC; 520 Adhesive.
   c. Foster Products Corporation, H. B. Fuller Company; 85-75.
   d. RBX Corporation; Rubatex Contact Adhesive.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Products, Division of ITW; CP-82.
   c. ITW TACC, Division of Illinois Tool Works; S-90/80.
   d. Marathon Industries, Inc.; 225.
   e. Mon-Eco Industries, Inc.; 22-25.


1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Products, Division of ITW; CP-82.
E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Dow Chemical Company (The); 739, Dow Silicone.
   d. Speedline Corporation; Speedline Vinyl Adhesive.

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

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. Childers Products, Division of ITW; CP-35.
   b. Foster Products Corporation, H. B. Fuller Company; 30-90.
   c. ITW TACC, Division of Illinois Tool Works; CB-50.
   d. Marathon Industries, Inc.; 590.
   e. Mon-Eco Industries, Inc.; 55-40.
   f. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

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. Childers Products, Division of ITW; CP-10.
   b. Foster Products Corporation, H. B. Fuller Company; 35-00.
c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
e. Mon-Eco Industries, Inc.; 55-50.
f. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F.
4. Solids Content: 63 percent by volume and 73 percent by weight.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Products, Division of ITW; CP-52.
   b. Foster Products Corporation, H. B. Fuller Company; 81-42.
   c. Marathon Industries, Inc.; 130.
   d. Mon-Eco Industries, Inc.; 11-30.
   e. Vimasco Corporation; 136.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment, and pipe insulation.

   4. Service Temperature Range: Minus 50 to plus 180 deg F.

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Products, Division of ITW; CP-76-8.
   b. Foster Products Corporation, H. B. Fuller Company; 95-44.
   c. Marathon Industries, Inc.; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Vimasco Corporation; 750.
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3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Fire- and water-resistant, flexible, elastomeric sealant.
5. Service Temperature Range: Minus 40 to plus 250 deg F.
7. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Products, Division of ITW; CP-76.

3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Fire- and water-resistant, flexible, elastomeric sealant.
5. Service Temperature Range: Minus 40 to plus 250 deg F.
7. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Johns Manville; Zeston.
   c. Proto PVC Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
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.
5. Factory-fabricated tank heads and tank side panels.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   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. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
      b. Compac Corp.; 104 and 105.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch 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 C 1136.
   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. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      b. Compac Corp.; 110 and 111.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
      d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
2.9 SECUREMENTS

A. Bands:

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. Childers Products; Bands.
b. PABCO Metals Corporation; Bands.
c. RPR Products, Inc.; Bands.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing or closed seal.

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-diameter shank, length to suit depth of insulation indicated.
   
a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   1) AGM Industries, Inc.; CWP-1.
   2) GEMCO; CD.
   3) Midwest Fasteners, Inc.; CD.
   4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   
a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   1) AGM Industries, Inc.; CWP-1.
   2) GEMCO; Cupped Head Weld Pin.
   3) Midwest Fasteners, Inc.; Cupped Head.
   4) Nelson Stud Welding; CHP.

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. Comply with the following requirements:
   
a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
   2) GEMCO; Perforated Base.
3) Midwest Fasteners, Inc.; Spindle.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-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.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   1) AGM Industries, Inc.; RC-150.
   2) GEMCO; R-150.
   3) Midwest Fasteners, Inc.; WA-150.
   4) Nelson Stud Welding; Speed Clips.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install in accordance with the Energy Conservation Code of New York State.

B. Install in accordance with the Mechanical Code of New York State.
C. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.

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

E. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

F. Install insulation with longitudinal seams at top and bottom of horizontal runs.

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

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

I. Keep insulation materials dry during application and finishing.

J. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

K. Install insulation with least number of joints practical.

L. 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.
   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.

M. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

N. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. 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 o.c.

   a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

O. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

P. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

Q. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

R. 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.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations.

   1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firesopping and fire-resistive joint sealers.

3.5 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.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as 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.

3. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two 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.

4. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

5. 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.

6. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

3.6 MINERAL-FIBER INSULATION INSTALLATION

A. Blanket 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 and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   
   b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches 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 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 from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch 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 operating below 50 deg F at 18-foot intervals. Vapor stops shall 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 2 times the insulation thickness but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches 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-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts: 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 and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches 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 over-compress 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 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 from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
HVAC INSULATION

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 at 18-foot intervals. Vapor stops shall 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 2 times the insulation thickness but not less than 3 inches.

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.

5. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. 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 shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

2. 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 three 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.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 DUCT INSULATION SCHEDULE, GENERAL

A. Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, exposed return located in nonconditioned space.
4. Indoor, concealed exhaust between isolation damper and penetration of building exterior or 10'-0" of horizontal duct main from building envelope penetration whichever is greater.

B. Items Not Insulated:

1. Factory-insulated flexible ducts.
2. Factory-insulated plenums and casings.
3. Flexible connectors.
5. Factory-insulated access panels and doors.

3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range.

B. Piping insulation thicknesses scheduled below are based on insulation having a conductivity k not exceeding 0.27 btu per inch / (hr) (ft²) (deg F).

3.10 PIPING INSULATION SCHEDULE

A. Heating-Hot-Water and Glycol Supply and Return, 200 Deg F and below:

1. All pipe sizes up to NPS 12”: Insulation shall be the following:

B. Condensate Drain Piping and Tubing Insulation and Jacket Requirements:

1. Flexible Elastomeric Insulation:
   a. Closed-cell, sponge- or expanded-rubber materials, complying with ASTM C534, Type I for tubular materials.
   b. Indoors: 1 inch thick.
   c. Outdoors: 1 inch thick.

2. Field-Applied Jacket:
   a. Concealed: None required.
   b. Indoors, Exposed to View: PVC, 20 mils thick.
   c. Outdoors, Exposed to View: Aluminum, smooth, 0.020 inch thick.

C. Refrigerant Tubing Insulation and Jacket Requirements:

1. Flexible Elastomeric Insulation:
   a. Closed-cell, sponge- or expanded-rubber materials, complying with ASTM C534, Type I for tubular materials.
b. Indoors: 1 inch thick.
c. Outdoors: 1 inch thick.

2. Field-Applied Jacket:
   a. Concealed: None required.
   b. Indoors, Exposed to View: PVC, 20 mils thick.
   c. Outdoors, Exposed to View: Aluminum, smooth, 0.020 inch thick.

END OF SECTION 230700
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SECTION 230800 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes commissioning process requirements for the following HVAC&R systems, assemblies, and equipment:

1. Unit ventilators.
2. Controls and instrumentation, including BAS and VRF controls.
3. Systems testing and balancing verification, including heating-water piping systems.
4. Systems testing and balancing verification, including heating-water piping systems supply-air systems return-air systems.
5. Automatic lighting controls including occupancy sensors, time-switch controls, and daylight responsive controls.
6. Service hot water heating systems including hot water heaters, process water systems, and associated controls.

1.3 DEFINITIONS

A. BAS: Building automation system.
B. DDC: Direct digital controls.
D. "Systems," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
E. TAB: Testing, adjusting, and balancing.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For BAS and HVAC&R Testing Technician.
B. Construction Checklists: See related Sections for technical requirements for the following construction checklists:
1. Vibration and seismic controls for HVAC&R piping and equipment.
2. Instrumentation and control for HVAC&R.
3. Refrigerant piping.
4. Terminal units.
5. Roof top air handling units.

1.5 QUALITY ASSURANCE

A. BAS Testing Technician Qualifications: Technicians to perform BAS construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:

1. Journey-level or equivalent skill level with knowledge of BAS, HVAC&R, electrical concepts, and building operations.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.

B. HVAC&R Testing Technician Qualifications: Technicians to perform HVAC&R construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:

1. Journey-level or equivalent skill level. Vocational School four-year program graduate or an Associates degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC&R systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC&R equipment, assemblies, and systems.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. One of the following:
   b. Associated Air Balance Council (AABC) Certified Test and Balance Technician.
   c. Owner retains the right to waive NEBB or AABC Certification.

C. Testing Equipment and Instrumentation Quality and Calibration: For test equipment and instrumentation required to perform HVAC&R commissioning work, perform the following:

1. Submit test equipment and instrumentation list. For each equipment or instrument, identify the following:
   a. Equipment/instrument identification number.
   b. Planned commissioning application or use.
   c. Manufacturer, make, model, and serial number.
d. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.

2. Test equipment and instrumentation shall meet the following criteria:
   a. Capable of testing and measuring performance within the specified acceptance criteria.
   b. Be calibrated at the manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
   c. Be maintained in good repair and operating condition throughout the duration of use on this Project.
   d. Be recalibrated/repaiired if dropped or damaged in any way since last calibrated.

D. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the commissioning process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, perform the following:
   a. Submit proprietary instrumentation and tools list. For each instrument or tool, identify the following:
      1) Instrument or tool identification number.
      2) Equipment schedule designation of equipment for which the instrument or tool is required.
      3) Manufacturer, make, model, and serial number.
      4) Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.
   b. Include a separate list of proprietary test instrumentation and tools in the operation and maintenance manuals.
   c. HVAC&R proprietary test instrumentation and tools become the property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL TESTING REQUIREMENTS

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents and approved Shop Drawings and submittals.
B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved Shop Drawings and submittals, and that pretest set points have been recorded.

C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.

F. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and response according to acceptance criteria.

G. Construction Checklists: Prepare and submit detailed construction checklists for HVAC&R systems, subsystems, equipment, and components.

   1. Contributors to the development of construction checklists shall include, but are not limited to, the following:
      a. HVAC&R systems and equipment installers.
      b. TAB technicians.
      c. HVAC&R instrumentation and controls installers.

H. Perform tests using design conditions, whenever possible.

   1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by Commissioning Coordinator and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.

   2. Commissioning test procedures may direct that set points be altered when simulating conditions is impractical.

   3. Commissioning test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to Owner. After deficiencies are resolved, reschedule tests.

J. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.
K. Coordinate schedule with, and perform the following activities at the direction of, Commissioning Coordinator.

L. Comply with construction checklist requirements, including material verification, installation checks, start-up, and performance tests requirements specified in Sections specifying HVAC systems and equipment.

M. Provide technicians, instrumentation, tools, and equipment to complete and document the following:
   1. Performance tests.
   2. Demonstration of a sample of performance tests.
   3. Commissioning tests.

3.2 TAB COMMISSIONING TESTS

A. TAB Verification:
   1. Prerequisites: Completion of "Examination" Article requirements and correction of deficiencies, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
   2. Completion of "Preparation" Article requirements for preparation of a TAB plan that includes strategies and step-by-step procedures, and system-readiness checks and reports, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
   3. Scope: HVAC&R air systems and hydronic piping systems.
   4. Purpose: Differential flow relationships intended to maintain air pressurization differentials between the various areas of Project.
   5. Conditions of the Test:
      a. Commissioning Test Demonstration Sampling Rate: As specified in "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
      b. Systems operating in full heating mode with minimum outside-air volume.
      c. Systems operating in full cooling mode with minimum outside-air volume.
      d. For measurements at air-handling units with economizer controls; systems operating in economizer mode with 100 percent outside air.
   6. Acceptance Criteria:
      a. Under all conditions, rechecked measurements comply with "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
      b. Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than two times the tolerances allowed.
      c. Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.
3.3 TERMINAL UNIT EQUIPMENT COMMISSIONING TESTS

A. Unit Ventilators:

1. Prerequisites: Installation verification of the following:
   
   a. Occupancy Input Device: Occupancy sensor.
   b. Occupancy Output Device: DDC system binary output.
   c. Room Temperature Input Device: Room thermostat.
   d. Room Temperature Output Device: Electronic damper actuators and control-valve operators.
   e. Display the following at the operator's workstation:
      
      1) Room/area served.
      2) Room occupied/unoccupied.
      3) Room temperature indication.
      4) Room temperature set point.
      5) Room temperature set point, occupied.
      6) Room temperature set point, unoccupied.
      7) Air-damper position as percentage open.
      8) Hot water control-valve position as percentage open.
      9) LEV valve operation.
     10) Remote condensing unit status.

2. Scope: Unit ventilator with hydronic heating coils and variable refrigerant flow DX cooling coils in supply-air systems, and associated controls.

3. Purpose:
   
   a. Occupancy-dependent room temperature set-point reset.
   b. Room temperature control.

4. Conditions of the Test:
   
   a. Commissioning Test Demonstration Sampling Rate: 10 percent of each model/size unit.
   b. Temperature Control - Occupied: Start with the room unoccupied. Occupy the room and observe the change to occupied status. Observe temperature control until room temperature is stable at occupied set point plus or minus 1.0 deg F.
   c. Temperature Control - Unoccupied: Start with the room occupied. Vacate the room and observe the change to unoccupied status. Observe temperature control until room temperature is stable at unoccupied set point plus or minus 1.0 deg F.
   d. Fan Speed – Unit shall respond to differential between room temperature and setpoint by adjusting fan speed with high speed associated with larger differential.

5. Acceptance Criteria:
   
   a. Temperature Control - Occupied:
1) Control system status changes from "occupied" to "unoccupied" after the specified time.
2) Room temperature is stable at occupied set point plus or minus 1.0 deg F within 10 minutes of occupancy. Room temperature does not overshoot or undershoot set point by more than 2.0 deg F during transition.
   a) Fan speed should track temperature differential.

b. Temperature Control - Unoccupied:

   1) Control system status changes from "unoccupied" to "occupied" immediately.
   2) Room temperature is stable at unoccupied set point plus or minus 1.0 deg F within 30 minutes of occupancy.
      a) Fan speed should be set to low.

3.4 AIR-HANDLING AND ROOFTOP UNIT SYSTEM COMMISSIONING TESTS

A. Supply Fan(s) Variable-Volume Control:
   1. Prerequisites: Installation verification of the following:
      a. Volume Control Input Device: Differential-pressure switch sensing supply-duct static pressure referenced to conditioned-space static pressure.
      b. Volume Control Output Device: DDC system analog output to modulating damper actuator.
   2. Scope: Variable-air-volume supply fan units and associated controls.
   3. Purpose:
      a. Supply-air discharge static pressure control.
      b. Response to excess supply-air discharge static pressure condition.
   4. Conditions of the Test:
      a. Minimum supply-air flow.
      b. Midrange Supply-Air Flow: 50 to 60 percent of maximum.
      c. Maximum supply-air flow.
      d. Excess supply-air discharge static pressure.
   5. Acceptance Criteria:
      a. At all supply-air flow rates, and during changes in supply-air flow, discharge air static pressure is at set point plus or minus 2 percent.
      b. Fan stops and an alarm is initiated at the operator's workstation when supply-air discharge static pressure is at the excess static pressure plus or minus 2 percent.

3.5 LIGHTING SYSTEM COMMISSION TESTS

A. Lighting Functional Testing;
   1. Provide functional testing per section of C408.3.1 of the International Energy Conservation Code prior to passing final inspection. Testing shall include the following installed components:
      a. Occupant sensor controls
         1) Projects with seven or fewer occupant sensors, test each sensor.
2) Projects with more than seven occupant sensors, testing shall be done for each unique combination of sensor type and geometry, not less than 10% of each one.

b. Time-switch controls.

B. SERVICE HOT WATER EQUIPMENT TESTS
1. Functional testing shall include all modes and sequences of operation under full-load and part-load conditions and all requirements of section C408 of the International Energy Conservation Code.
2. Test all controls and verify that all calibration and adjustment have been made to bring the performance within specified parameters.
3. Verify that all specified alarms and safety controls are functional.
4. Report failure of any equipment to meet test requirements.
5. Equipment to be tested include, but are not limited to:
   a. Domestic Water Heaters
   b. Pressurized Washing Systems
   c. Domestic Water Pumps

END OF SECTION 230800
SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. See specification section 238129 – Variable Refrigerant Flow HVAC Systems for additional control system requirements and coordination.

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1.3 DEFINITIONS

A. DDC: Direct digital control.
B. I/O: Input/output.
C. MS/TP: Master slave/token passing.
D. PC: Personal computer.
E. PID: Proportional plus integral plus derivative.
F. RTD: Resistance temperature detector.

1.4 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
2. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
3. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
4. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:

   a. Water Temperature: Plus or minus 1 deg F.
   b. Water Flow: Plus or minus 5 percent of full scale.
   c. Water Pressure: Plus or minus 2 percent of full scale.
   d. Space Temperature: Plus or minus 1 deg F.
   e. Ducted Air Temperature: Plus or minus 1 deg F.
f. Outside Air Temperature: Plus or minus 2 deg F.
g. Temperature Differential: Plus or minus 0.25 deg F.
h. Relative Humidity: Plus or minus 5 percent.
i. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
j. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
k. Airflow (Terminal): Plus or minus 10 percent of full scale.
l. Air Pressure (Space): Plus or minus 0.01-inch wg.
m. Air Pressure (Ducts): Plus or minus 0.1-inch wg.

1.5 SEQUENCE OF OPERATION – See Drawings.

1.6 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.

2. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. DDC System Hardware:
   a. Wiring diagrams for control units with termination numbers.
   b. Schematic diagrams and floor plans for field sensors and control hardware.
   c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

9. Controlled Systems:
a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.

b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.

c. Written description of sequence of operation including schematic diagram.

d. Points list.

1.7 INFORMATIONAL SUBMITTALS

A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

B. Field quality-control test reports.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

B. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Software license required by and installed for DDC workstations and control systems.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Replacement Materials: One replacement diaphragm or relay mechanism for each unique valve, motor controller, thermostat positioning relay.
1.10 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with ASHRAE 135 for DDC system components.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.12 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Basis of Design: Siemens APOGEE. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
   a. Johnson Controls, Inc.; Controls Group.
   b. TAC Americas, INC.
   c. Trane

2. Regardless of manufacturer, all control work shall integrate seamlessly with the existing Siemens APOGEE Control System’s server, include the generation of new and modification of existing graphics, setpoint, monitoring and control sequences included in the scope of work. Gateways are not acceptable.
2.2 CONTROL SYSTEM

A. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

2.3 DDC EQUIPMENT

A. Operator Workstation: One PC-based microcomputer(s) with minimum configuration as follows:

1. Motherboard: With 8 integrated USB 2.0 ports, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.
2. Processor: Intel Pentium 4, MHz.
3. Random-Access Memory: 512 MB.
4. Graphics: Video adapter, minimum 1280 x 1024 pixels, 64-MB video memory, with TV out.
5. Monitor: 19 inches, LCD color.
7. Floppy-Disk Drive: 1.44 MB.
8. Hard-Disk Drive: 80 GB.
9. CD-ROM Read/Write Drive: 48x24x48.
10. Mouse: Three button, optical.
12. Operating System: Microsoft Windows XP Professional with high-speed Internet access.

   a. ASHRAE 135 Compliance: Workstation shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

13. Printer: Color, ink-jet type as follows:

   a. Print Head: 4800 x 1200 dpi optimized color resolution.
   b. Paper Handling: Minimum of 100 sheets.
   c. Print Speed: Minimum of 17 ppm in black and 12 ppm in color.

14. Application Software:

   a. I/O capability from operator station.
   b. System security for each operator via software password and access levels.
   c. Automatic system diagnostics; monitor system and report failures.
   d. Database creation and support.
   e. Automatic and manual database save and restore.
   f. Dynamic color graphic displays with up to 10 screen displays at once.
g. Custom graphics generation and graphics library of HVAC equipment and symbols.

h. Alarm processing, messages, and reactions.

i. Trend logs retrievable in spreadsheets and database programs.

j. Alarm and event processing.

k. Object and property status and control.

l. Automatic restart of field equipment on restoration of power.

m. Data collection, reports, and logs. Include standard reports for the following:

1) Current values of all objects.
2) Current alarm summary.
3) Disabled objects.
4) Alarm lockout objects.
5) Logs.

n. Custom report development.

o. Utility and weather reports.

p. Workstation application editors for controllers and schedules.

q. Maintenance management.

15. Custom Application Software:

a. English language oriented.

b. Full-screen character editor/programming environment.

c. Allow development of independently executing program modules with debugging/simulation capability.

d. Support conditional statements.

e. Support floating-point arithmetic with mathematic functions.

f. Contains predefined time variables.

B. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.

2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a. Global communications.

b. Discrete/digital, analog, and pulse I/O.

c. Monitoring, controlling, or addressing data points.

d. Software applications, scheduling, and alarm processing.

e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Standard Application Programs:
INSTRUMENTATION AND CONTROL FOR HVAC

a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on/off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
c. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.
d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
e. Remote communications.
f. Maintenance management.
g. Units of Measure: Inch-pound and SI (metric).

4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

C. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
   a. Global communications.
   b. Discrete/digital, analog, and pulse I/O.
   c. Monitoring, controlling, or addressing data points.
3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

D. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
6. **Tri-State Outputs:** Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.

7. **Universal I/Os:** Provide software selectable binary or analog outputs.

**E. Power Supplies:** Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

**F. Power Line Filtering:** Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

### 2.4 UNITARY CONTROLLERS

**A.** Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

1. **Configuration:** Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
2. **Operating System:** Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
3. **ASHRAE 135 Compliance:** Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
4. **Enclosure:** Dustproof rated for operation at 32 to 120 deg F.
5. **Enclosure:** Waterproof rated for operation at 40 to 150 deg F.

### 2.5 ANALOG CONTROLLERS

**A.** Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.
B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
   1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

E. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.
   1. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig.
   2. Proportional band shall extend from 2 to 20 percent for 5 psig.
   3. Authority shall be 20 to 200 percent.
   4. Gages: 2-1/2 inches in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

2.6 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:
   1. Accuracy: Plus or minus 0.5 deg F at calibration point.
   2. Wire: Twisted, shielded-pair cable.
   3. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
   4. Averaging Elements in Ducts: 36 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft.
   5. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
   6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
      a. Set-Point Adjustment: Concealed.
      b. Set-Point Indication: Concealed.
      c. Thermometer: Concealed.
      d. Color: White
7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

C. RTDs and Transmitters:

1. Accuracy: Plus or minus 0.2 percent at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
4. Averaging Elements in Ducts: 18 inches long, rigid; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
5. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
   a. Set-Point Adjustment: Concealed.
   b. Set-Point Indication: Concealed.
   c. Thermometer: Concealed.

7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

D. Humidity Sensors: Bulk polymer sensor element.

1. Accuracy: 2 percent full range with linear output.
2. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
3. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of minus 22 to plus 185 deg F.
4. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

E. Pressure Transmitters/Transducers:

1. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
   a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
   b. Output: 4 to 20 mA.
   c. Building Static-Pressure Range: 0- to 0.25-inch wg.
   d. Duct Static-Pressure Range: 0- to 5-inch wg.

2. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
3. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
4. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
5. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

F. Room Sensor Cover Construction: Manufacturer's standard locking covers.

2.7 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.
B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.
C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

2.8 FLOW MEASURING STATIONS

A. Duct Airflow Station: Combination of air straightener and multiport, self-averaging pitot tube station.
   3. Sensing Manifold: Copper manifold with bullet-nosed static pressure sensors positioned on equal area basis.
2.9 THERMOSTATS

A. Mercury thermometers and sensors are not permitted.

B. Electric, solid-state, microcomputer-based room thermostat with remote sensor.
   1. Automatic switching from heating to cooling.
   2. Preferential rate control to minimize overshoot and deviation from set point.
   3. Set up for four separate temperatures per day.
   4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
   5. Short-cycle protection.
   6. Programming based on every day of week.
   7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
   8. Battery replacement without program loss.
   9. Thermostat display features include the following:
      a. Time of day.
      b. Actual room temperature.
      c. Programmed temperature.
      d. Programmed time.
      e. Duration of timed override.
      f. Day of week.
      g. System mode indications include "heating," "off," "fan auto," and "fan on."

C. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.
   1. Bulbs in water lines with separate wells of same material as bulb.
   2. Bulbs in air ducts with flanges and shields.
   3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
   4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
   5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
   6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

D. Fire-Protection Thermostats: Listed and labeled by an NRTL acceptable to authorities having jurisdiction; with fixed or adjustable settings to operate at not less than 75 deg F above normal maximum operating temperature, and the following:
   2. Reset: Automatic, with control circuit arranged to require manual reset at central control panel; with pilot light and reset switch on panel labeled to indicate operation.

E. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.
F. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.

G. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
   2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

H. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.
   2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

I. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig, and cast housing with position indicator and adjusting knob.

2.10 HUMIDISTATS

A. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

2.11 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
   1. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
   2. 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.
   3. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and
   4. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
   1. Manufacturers:
a. Belimo Aircontrols (USA), Inc.

2. Valves: Size for torque required for valve close off at maximum pump differential pressure.

3. Dampers: Size for running torque calculated as follows:
   b. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.


5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.


7. Power Requirements (Two-Position Spring Return): 24-V ac.

8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.

9. Proportional Signal: 2-10-V dc or 4-20 mA, and 2-10-V dc position feedback signal.

10. Temperature Rating: Minus 22 to plus 122 deg F.

11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.

12. Run Time: 12 seconds open, 5 seconds closed.

2.12 CONTROL VALVES

A. Manufacturers:

2. Neles-Jamesbury.
3. Parker Hannifin Corporation; Skinner Valve Division.
4. Pneuline Controls.
5. Sauter Controls Corporation.

B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

C. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.

2. Internal Construction: Replaceable plugs and stainless-steel or brass seats.
   a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
   b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.

3. Sizing: 3-psig maximum pressure drop at design flow rate or the following:
   b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
4. Flow Characteristics: Two-way valves shall have equal percentage characteristics.

5. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

D. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.
   1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
   2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.
   3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Verify that conditioned power supply is available to control units and operator workstation.

3.2 INSTALLATION
   A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
   B. Connect and configure equipment and software to achieve sequence of operation specified.
   A. Verify location of thermostats with Drawings and room details before installation. Install devices 48 inches above the floor.
   B. Install guards on thermostats in the following locations:
      1. Entrances.
      2. Public areas.
      3. Where indicated.
   C. Install labels and nameplates to identify control components according to Section 230553 "Identification for HVAC Piping and Equipment."
   D. Install hydronic instrument wells, valves, and other accessories according to Section 232113 Hydronic Piping Specialties."
   E. Install refrigerant instrument wells, valves, and other accessories according to Section 232300 "Refrigerant Piping."
3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Section 260533 "Raceways and Boxes for Electrical Systems."

B. Install building wire and cable according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Install signal and communication cable as follows:

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable in raceway.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
4. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
5. Test each point through its full operating range to verify that safety and operating control set points are as required.
6. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
7. Test each system for compliance with sequence of operation.
8. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check installation of air supply for each instrument.
6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
8. Check temperature instruments and material and length of sensing elements.
9. Check control valves. Verify that they are in correct direction.
10. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
11. Check DDC system as follows:
   a. Verify that DDC controller power supply is from emergency power supply, if applicable.
   b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
   c. Verify that spare I/O capacity has been provided.
   d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
   a. Check analog inputs at 0, 50, and 100 percent of span.
   b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
   c. Check digital inputs using jumper wire.
   d. Check digital outputs using ohmmeter to test for contact making or breaking.
   e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Flow:
a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
b. Manually operate flow switches to verify that they make or break contact.

6. Pressure:
   a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
   b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:
   a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
   b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 230900
SECTION 230924 - CONTROL VALVES

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 control valves and actuators for DDC systems.
B. Related Requirements:
   1. Section 230900 "Instrumentation and Control for HVAC" control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.3 DEFINITIONS
A. Cv: Design valve coefficient.
B. DDC: Direct-digital control.
C. NBR: Nitrile butadiene rubber.
D. PTFE: Polytetrafluoroethylene

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product, including the following:
   1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
   4. Installation, operation, and maintenance instructions, including factors affecting performance.
B. Shop Drawings:
   1. Include plans, elevations, sections, and mounting details.
2. Include details of product 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.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Control valve installation location shown in relationship to room, duct, pipe, and equipment.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For control valves to include in 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 a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.

C. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.

D. Determine control valve sizes and flow coefficients by ISA 75.01.01.

E. Control valve characteristics and rangeability shall comply with ISA 75.11.01.

F. Selection Criteria:

1. Control valve shutoff classifications shall be FCI 70-2, Class IV or better unless otherwise indicated.

2. Valve pattern, three-way or straight through, shall be as indicated on Drawings.

3. Modulating straight-through pattern control valves shall have equal percentage flow-throttling characteristics unless otherwise indicated.

4. Modulating three-way pattern water valves shall have linear flow-throttling characteristics. The total flow through the valve shall remain constant regardless of the valve's position.

5. Rotary-type control valves, such as ball valves, shall have Cv falling between 65 and 75 degrees of valve full open position and minimum valve Cv between 15 and 25 percent of open position.
6. Selection shall consider viscosity, flashing, and cavitation corrections.
7. Valves shall have stable operation throughout full range of operation, from design to minimum Cv.
8. Minimum Cv shall be calculated at 10 percent of design flow, with a coincident pressure differential equal to the system design pump head.
9. In water systems, select modulating control valves at terminal equipment for a design Cv based on a pressure drop of 5 psig at design flow unless otherwise indicated.
10. Two-position control valves shall be line size unless otherwise indicated.
11. In water systems, use ball-style control valves for two-position control for valves NPS 2 and smaller and butterfly style for valves larger than NPS 2.

2.2 BALL-STYLE CONTROL VALVES

A. Ball Valves with Single Port and Segmented Ball:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Valve Solutions, Inc.
   b. Belimo Aircontrols (USA), Inc.
   c. HCI; Hydronics Components Inc.

2. Performance:
   a. Process Temperature Rating: Minus 20 to plus 450 deg F.
   b. ASME B16.34, Class 150.
   c. Leakage: FCI 70-2, Class IV.
   d. Rangeability: 300 to 1.
   e. Rotation: Zero to 90 degrees.
   f. Equal percentage flow characteristic.

3. ASME B16.10 face-to-face dimensions.
4. Valves NPS 2 and Smaller: Threaded (NPT) ends.
5. Valves NPS 2-1/2 through NPS 6: Flanged ends suitable for mating to ASME B16.5 flanges.
8. Shaft and Segmented Ball: Pinned and welded.
11. Replaceable seat, ball, and shaft packing.
12. Label each valve with following:
   a. Manufacturer's name, model number, and serial number.
   b. Body size.
   c. Flow directional arrow.
B. Ball Valves with Segmented Ball, Three-Way Pattern:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   
a. Valve Solutions, Inc.
b. Belimo Aircontrols (USA), Inc.
c. HCI; Hydronics Components Inc.

2. Arrangement: Two single-port valves mated to a fabricated tee with interconnecting mechanical linkage.

3. Performance:
   
a. Process Temperature Rating: Minus 20 to plus 450 deg F.
b. ASME B16.34, Class 150.
c. Leakage: FCI 70-2, Class IV.
d. Rangeability: 300 to 1.
e. Rotation: Zero to 90 degrees.
f. Equal percentage flow characteristic.

5. Valves NPS 3 through NPS 6: Flanged ends suitable for mating to ASME B16.5 flanges.
8. Shaft and Segmented Ball: Pinned and welded.
11. Replaceable seat, ball, and shaft packing.
12. Label each valve with following:
   
a. Manufacturer's name, model number, and serial number.
b. Body size.
c. Flow directional arrow.

C. Pressure-Independent Ball Valves NPS 2 and Smaller:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   
a. Belimo Aircontrols (USA), Inc.
b. HCI; Hydronics Components Inc.

2. Performance:
   
a. Pressure Rating: 600 psig for NPS 1 and 400 psig for NPS 1-1/2 and NPS 2.
b. Close-off pressure of 200 psig.
c. Process Temperature Range: Between zero to 212 deg F.
d. Rangeability: 100 to 1.

3. Integral Pressure Regulator: Located upstream of ball to regulate pressure, to maintain a constant pressure differential while operating within a pressure differential range of 5 to 50 psig.


5. Ball: Chrome-plated brass.


7. Stem sleeve or other approved means to allow valve to be opened and closed without damaging field-applied insulation and insulation vapor barrier seal.

8. Ball Seats: Reinforced PTFE.

9. Stem Seal: Reinforced PTFE packing ring stem seal with threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if equivalent cycle endurance can be achieved.


2.3 ELECTRIC AND ELECTRONIC CONTROL VALVE ACTUATORS

A. Actuators for Hydronic Control Valves: Capable of closing valve against system pump shutoff head.

B. Position indicator and graduated scale on each actuator.

C. Type: Motor operated, with or without gears, electric and electronic.

D. Voltage: 24-V ac.

E. Deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.

F. Function properly within a range of 85 to 120 percent of nameplate voltage.

G. Construction:

1. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.

2. For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.

H. Field Adjustment:

1. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.

I. Two-Position Actuators: Single direction, spring return or reversing type.
J. Modulating Actuators:

1. Operation: Capable of stopping at all points across full range, and starting in either direction from any point in range.

2. Control Input Signal:

   a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position and other input drives actuator to close position. No signal of either input remains in last position.

   b. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10- or 2- to 10-V dc and 4- to 20-mA signals.

   c. Pulse Width Modulation (PWM): Actuator drives to a specified position according to pulse duration (length) of signal from a dry contact closure, triac sink, or source controller.

   d. Programmable Multi-Function:

      1) Control Input, Position Feedback, and Running Time: Factory or field programmable.

      2) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.

      3) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.

K. Fail-Safe:

1. Where indicated, provide actuator to fail to an end position.

2. Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.

3. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

L. Integral Overload Protection:

1. Provide against overload throughout the entire operating range in both directions.

2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

M. Valve Attachment:

1. Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to valve shaft without the need for connecting linkages.

2. Attach actuator to valve drive shaft in a way that ensures maximum transfer of power and torque without slippage.

3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for valves installed in piping to verify actual locations of piping connections before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy most stringent requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Properly support instruments, wiring, and conduits to comply with requirements indicated.

D. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

E. Firestop penetrations made in fire-rated assemblies and seal penetrations made in acoustically rated assemblies.

F. Fastening Hardware:

1. Stillson wrenches, pliers, and other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.

2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.

3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

G. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.3 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
C. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 CONTROL VALVES

A. Install pipe reducers for valves smaller than line size. Position reducers as close to valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.

B. Install flanges or unions to allow drop-in and -out valve installation.

C. Install drain valves in piping upstream and downstream of each control valve installed in a three-valve manifold and for each control valve larger than NPS 2.

D. Valve Orientation:
   1. Where possible, install globe and ball valves installed in horizontal piping with stems upright and not more than 15 degrees off of vertical, not inverted.
   2. Install valves in a position to allow full stem movement.
   3. Where possible, install butterfly valves that are installed in horizontal piping with stems in horizontal position and with low point of disc opening with direction of flow.

E. Clearance:
   1. Locate valves for easy access and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.
   2. Install valves with at least 12 inches of clear space around valve and between valves and adjacent surfaces.

F. Threaded Valves:
   1. Note internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
   2. Align threads at point of assembly.
   3. Apply thread compound to external pipe threads, except where dry seal threading is specified.
   4. Assemble joint, wrench tight. Apply wrench on valve end as pipe is being threaded.

3.5 CONNECTIONS

A. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at
points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.7 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

3.8 CHECKOUT PROCEDURES

A. Control Valve Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.
2. Check valves for proper location and accessibility.
3. Check valves for proper installation for direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
4. Verify that control valves are installed correctly for flow direction.
5. Verify that valve body attachment is properly secured and sealed.
6. Verify that valve actuator and linkage attachment are secure.
7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
8. Verify that valve ball, disc, and plug travel are unobstructed.
9. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

3.9 ADJUSTMENT, CALIBRATION, AND TESTING

A. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.

C. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

END OF SECTION 230924
SECTION 231000 – FACILITY VEHICLE FUEL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

2. Diesel Fuel and Gasoline Dispensing System.

1.3 DEFINITIONS

A. GPM: Gallons Per Minute delivered from Fuel Pump and Dispensing System.

1.4 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 diagrams for power, signal, and control wiring.
2. Include information for wireless data signaling and collection system, software and hardware.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For Fuel System Equipment.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fuel Filters, Inlet Filter Elements: Provide 2 replacement elements for each element installed.

1.7 FIELD CONDITIONS

A. Interruption of Existing Fueling Stations: 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 Owner no fewer than two days in advance of proposed interruption of compressed-air service.
2. Do not proceed with interruption of compressed-air service without Owner’s written permission.

1.8 COORDINATION

A. Coordinate sizes and locations of equipment supports and locate so as not to obstruct construction activities by other trades.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Devices and wiring shall also be rated for Class 1, Division 1, hazards locations.

B. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

C. Submersible Fuel Pumps to be installed in existing fuel/ gasoline storage tanks through existing nozzles. Coordinate, mounting, pump diameter and extension length of fuel pump with existing conditions.

D. Communication equipment and software to be included in the dispensing system for electronic fuel management.

2.2 GENERAL REQUIREMENTS FOR SUBMERSIBLE DIESEL FUEL/ GASOLINE PUMPS.

A. General Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.

B. Controls: Electrical controls and devices.

1. Enclosure: Class 1, Division 1, Group D unless otherwise indicated.
2. Submersible unit with air eliminator, check valve, pressure relief, shaft extension and threaded nipple connection.

C. Pump: 208/230 VAC, ¾ HP, fixed speed, two stage centrifugal pump with integral automatic thermal overload protection, 20 gpm at 90 feet of head, adjustable bypass valve.

2.3 DIESEL FUEL/ GASOLINE DISPENSER

A. Diesel Fuel or Gasoline Dispenser:

1. Wayne
2. GasBoy
3. Approved Equal.

B. Characteristics:

1. Shelf Mounted above ground storage tank,
2. Capacity: 20 GPM.
4. Working pressure: 50 psig Max.
5. ADA Compliance: ANSI A117.1
6. Warranty: 2 year from date of acceptance.
7. Basis of Design: Wayne Reliance , S1
8. Electrical Characteristics:
   b. Phase(s): Single
   c. Hertz: 60.
   d. Class I, Division 1, Group D.
9. Interlocked with pump and normally closed antiphon solenoid valve.
10. Diesel fuel or gasoline with up to 15% ethanol.

11. Accessories:
   a. Valve: 2 Stage.
   b. Finish: Weather resistant powder coat paint.
   c. Mounting: Shelf Type.
   d. Nozzle: Standard UL listed automatic nozzle
   e. Hose: Hose and hose support arm with swivels and breakaways.

2.4 Electronic Fuel Management System.

1. GIR Fuel Management Systems
2. OPW
3. Approved Equal.

B. Description: Fleet Electronic Fuel Management System to monitor dispensing of diesel fuel or gasoline from individual dispensers in a school bus fleet bus and support vehicles.
C. Characteristics:

1. Monitor and record the transfer of fuel through use of a numbered identification fob specific to one user.
2. Software based recordkeeping system, connected to a PC through an Ethernet connection and logged through proprietary software.
3. Capable of exporting data to Microsoft Excel and similar types of worksheets.
4. System will be capable of supporting up to 60 individual identification tags.
5. Two individual systems will be required. One for Diesel Fuel and one for Gasoline.
6. Software, technical support and troubleshooting to be included in the installation package.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Equipment Mounting:

1. Install air compressors, aftercoolers, and air dryers on cast-in-place concrete equipment base(s) for floor mounting and on steel supports for elevated equipment.
2. Provide vibration isolation pads for all rotating equipment.

B. Install compressed-air equipment anchored to substrate.

C. Arrange equipment so controls and devices are accessible for servicing.

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Install the following devices on compressed-air equipment:

1. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.
2. Pressure Regulators: Install downstream from air compressors.

3.2 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 machine, allow space for service and maintenance.
3.3 IDENTIFICATION

A. Identify general-service air compressors and components. Comply with requirements for identification specified in Section 220553 “Identification for Plumbing Piping and Equipment.”

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check for lubricating oil in lubricated-type equipment.
3. Check belt drives for proper tension.
4. Verify that air-compressor inlet filters and piping are clear.
5. Check for equipment vibration-control supports and flexible pipe connectors, and verify that equipment is properly attached to substrate.
6. Check safety valves for correct settings. Ensure that settings are higher than air-compressor discharge pressure, but not higher than rating of system components.
7. Drain receiver tanks.
8. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
9. Test and adjust controls and safeties.

3.5 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 231000
SECTION 231123 - FACILITY NATURAL-GAS PIPING

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. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
5. Dielectric fittings.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Piping and Piping specialties.
2. Corrugated, stainless-steel tubing with associated components.
3. Valves. Include pressure rating, capacity, and settings.
4. Dielectric fittings.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 1/4 inch per foot.
1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

B. Qualification Data: For qualified professional engineer.

C. Welding certificates.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For motorized gas valves pressure regulators to include in operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

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

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

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.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. 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.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

1.9 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.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only
after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural-gas service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressure within Buildings: 0.5 psig or less.

2.2 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   b. End Connections: Threaded or butt welding to match pipe.
   c. Lapped Face: Not permitted underground.
   e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
   a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

6. Mechanical Couplings:
a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1) Dresser Piping Specialties
2) GE Oil & Gas.
3) Smith-Blair, Inc.

b. Stainless steel flanges and tube with epoxy finish.
c. Buna-nitrile seals.
d. Stainless-steel bolts, washers, and nuts.
e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

2.3 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

2. Corrugated stainless-steel tubing with polymer coating.
3. Operating-Pressure Rating: 0.5 psig.
5. Threaded Ends: Comply with ASME B1.20.1.
6. Maximum Length: 72 inches

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: [40] [60]-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

D. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

2.4 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.


C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.5 MANUAL GAS SHUTOFF VALVES

A. See “Aboveground Manual Gas Shutoff Valve Schedule” Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. A.Y. McDonald Mfg. Co.
   b. Apollo Valves; Conbraco Industries, Inc.
   c. BrassCraft Manufacturing Co.; a Masco company.
   d. Lyall, R. W. & Company, Inc.
   e. Perfection Corporation.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Bronze Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. A.Y. McDonald Mfg. Co.
   b. Lee Brass Company.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Watts; a Watts Water Technologies company.
   b. Wilkins.
   c. Zurn Industries, LLC.
2. Description:
   b. Pressure Rating: 125 psig minimum at 180 deg F.
   c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Watts; a Watts Water Technologies company.
   c. Wilkins.

2. Description:
   b. Factory-fabricated, bolted, companion-flange assembly.
   c. Pressure Rating: 125 psig minimum at 180 deg F.
   d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Pipeline Seal and Insulator, Inc.
   2. Description:
      a. Nonconducting materials for field assembly of companion flanges.
      b. Pressure Rating: 150 psig.
      c. Gasket: Neoprene or phenolic.
      d. Bolt Sleeves: Phenolic or polyethylene.
      e. Washers: Phenolic with steel backing washers.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
   A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
   B. Inspect natural-gas piping according to 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 prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

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

B. Steel Piping with Protective Coating:
   1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
   2. Replace pipe having damaged PE coating with new pipe.

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

3.4 INDOOR PIPING INSTALLATION

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. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

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.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install piping free of sags and bends.

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

J. Verify final equipment locations for roughing-in.

K. 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.

   1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
   a. Exception: Tubing passing through partitions or walls does not require striker barriers.

3. Prohibited Locations:
   a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
   b. Do not install natural-gas piping in solid walls or partitions.

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

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

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

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

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.5 VALVE INSTALLATION

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

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

3.6 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:
   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 according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

G. 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, then use wrench. Do not overtighten.

3.7 HANGER AND SUPPORT INSTALLATION

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

B. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
   3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.

D. Install hangers for horizontal drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
   2. NPS 1/2 and NPS 5/8: Maximum span, 72 inches; minimum rod size, 3/8 inch.
   3. NPS 3/4 and NPS 7/8: Maximum span, 84 inches; minimum rod size, 3/8 inch.
4. NPS 1: Maximum span, 96 inches; minimum rod size, 3/8 inch.

E. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.8 CONNECTIONS

A. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

B. Install piping adjacent to appliances to allow service and maintenance of appliances.

C. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

3.10 PAINTING

A. Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.
   b. Topcoat: Exterior alkyd enamel flat

C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.
B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.12 OUTDOOR PIPING SCHEDULE

A. Aboveground natural-gas piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

3.13 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.

B. Valves in branch piping for single appliance shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.

END OF SECTION 231123
SECTION 232113 - HYDRONIC PIPING AND SPECIALTIES

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 pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. Copper tube and fittings.
2. Joining materials.
3. Dielectric fittings.

1.3 SUBMITTALS

A. Product Data: For each type of the following:

1. Pipe.
2. Fittings.
4. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
5. Air control devices.

B. Qualification Data: For Installer.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

1. Hot-Water Heating Piping: 150 psig at 200 deg F.
2. Condensate-Drain Piping: 80 psig 150 deg F.
3. Air-Vent Piping: 80 psig at 200 deg F.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type K, L, M (see Section 3.1 Piping Applications).

B. Wrought-Copper Fittings: ASME B16.22.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Anvil International, Inc.
   b. S. P. Fittings; a division of Star Pipe Products.
   c. Victaulic Company of America.

C. Copper or Bronze Pressure-Seal Fittings:

1. Housing: Copper.
2. O-Rings and Pipe Stops: EPDM.
3. Tools: Manufacturer's special tools.
4. Minimum 200-psig working-pressure rating at 250 deg F.

D. Wrought-Copper Unions: ASME B16.22.

2.3 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 thickness or specific material is 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.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

B. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      d. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.
   2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      b. Central Plastics Company.
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Central Plastics Company.
2. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

3. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Calpico, Inc.
   b. Lochinvar Corporation.

2. Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

G. Dielectric Nipples:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Perfection Corporation; a subsidiary of American Meter Company.
   b. Sioux Chief Manufacturing Company, Inc.
   c. Victaulic Company of America.

2. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded ends; and 300-psig minimum working pressure at 225 deg F.

2.5 VALVES

A. Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC."

C. Bronze, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett Domestic Pump; a division of ITT Industries.
   c. Taco.

2. Body: Bronze, Y pattern equal percentage globe style designed for proportional balancing.
a. Capable of precise flow measurement.
b. Precision flow balancing.
c. Positive shutoff with no-drip soft seat.

3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
8. CWP Rating: Minimum 125 psig.
9. Maximum Operating Temperature: 250 deg F.

2.6 AIR CONTROL DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amtrol, Inc.
   2. Armstrong Pumps, Inc.
   3. Bell & Gossett Domestic Pump; a division of ITT Industries.
   4. Taco.

B. Manual Air Vents:
   1. Body: Bronze.
   2. Internal Parts: Nonferrous.
   3. Operator: Screwdriver or thumbscrew.
   4. Inlet Connection: NPS 1/2.
   7. Maximum Operating Temperature: 225 deg F.

C. Automatic Air Vents:
   1. Body: Bronze or cast iron.
   2. Internal Parts: Nonferrous.
   4. Inlet Connection: NPS 1/2.
   7. Maximum Operating Temperature: 240 deg F.

2.7 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:
   1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for NPS 2 and smaller.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water piping, aboveground, NPS 2 and smaller, shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.

B. Cooling Unit Condensate-Drain Piping: Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

C. Air-Vent Piping:
   1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
   2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

D. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.2 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal. Provide additional calibrated-orifice balancing valves as shown on drawings.

3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such 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 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. Select system components with pressure rating equal to or greater than system operating pressure.
K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."
Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
R. Install shutoff valve immediately upstream of each dielectric fitting.
S. Install strainers on inlet side of each control valve, pressure-reducing valve, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
T. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."
U. Install sleeve seals for piping penetrations of concrete walls and slabs.
V. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.4 DIELECTRIC FITTING INSTALLATION
A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges nipples.
D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 HANGERS AND SUPPORTS
A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
   2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.

E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.6 PIPE JOINT CONSTRUCTION
A. Join pipe and fittings according to the following requirements and Division 23 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. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Threaded Joints: Thread pipe with tapered pipe threads according to 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 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.

F. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.7 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.

3.8 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."

3.9 SYSTEM FILL

A. For all glycol-water systems, contractor shall be responsible for the initial system fill with a pre-mixed glycol solution as follows:

1. 20% propylene glycol-water mixture by volume with corrosion inhibitors similar to DOWFROST HD
   a. Temperature range from -50 deg F to 325 deg F.
   b. Fluorescent dye for leak protections.
3.10 CHEMICAL TREATMENT – HOT WATER SYSTEMS

A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:

1. pH: 9.0 to 10.5.
2. "P" Alkalinity: 100 to 500 ppm.
3. Boron: 100 to 200 ppm.
4. Chemical Oxygen Demand: Maximum of 100 ppm. Revise this value if closed system contains glycol.
5. Corrosion Inhibitor:
   a. Sodium Nitrate: 1000 to 1500 ppm.
   b. Molybdate: 200 to 300 ppm.
   c. Chromate: 200 to 300 ppm.
   d. Sodium Nitrate Plus Molybdate: 100 to 200 ppm each.
   e. Chromate Plus Molybdate: 50 to 100 ppm each.

6. Soluble Copper: Maximum of 0.20 ppm.
7. Tolyiriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum of 10 ppm.
8. Total Suspended Solids: Maximum of 10 ppm.
11. Microbiological Limits:
   a. Total Aerobic Plate Count: Maximum of 1000 organisms/mL.
   b. Total Anaerobic Plate Count: Maximum of 100 organisms/mL.
   c. Nitrate Reducers: 100 organisms/mL.
   d. Sulfate Reducers: Maximum of zero organisms/mL.
   e. Iron Bacteria: Maximum of zero organisms/mL.

B. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

C. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

D. Fill systems with water or glycol solution as indicated.

3.11 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.

3. Isolate expansion tanks and determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.

2. Set makeup pressure-reducing valves for required system pressure.

3. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).

4. Set temperature controls so all coils are calling for full flow.

5. Inspect and set operating temperatures of hydronic equipment to specified values.

6. Verify lubrication of motors and bearings.

END OF SECTION 232113
SECTION 232300 - REFRIGERANT PIPING

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. Refrigerant pipes and fittings.
   2. Refrigerant piping valves and specialties.
   3. Refrigerants.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve, refrigerant piping, and piping specialty.
   1. Include pressure drop, based on manufacturer's test data, for the following:
      a. Service valves.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE


B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.6 PRODUCT STORAGE AND HANDLING

A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:


2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR.
B. Wrought-Copper Fittings: ASME B16.22.
C. Wrought-Copper Unions: ASME B16.22.
D. Brazing Filler Metals: AWS A5.8/A5.8M.
E. Flexible Connectors:

2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
5. Maximum Operating Temperature: 250 deg F.

2.3 VALVES AND SPECIALTIES

A. Service Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Danfoss Inc.
   b. Emerson Climate Technologies.
2. Body: Forged brass with brass cap including key end to remove core.
3. Core: Removable ball-type check valve with stainless-steel spring.
5. End Connections: Copper spring.
2.4 REFRIGERANTS

A. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      
      a. Arkema Inc.
      b. DuPont Fluorochemicals Div.
      c. Genetron Refrigerants; Honeywell International Inc.
      d. Mexichem Fluor Inc.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

   A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR drawn or annealed tubing and wrought-copper fittings with brazed joints.

   B. Hot-Gas and Liquid Lines: Copper, Type ACR drawn or annealed tubing and wrought-copper fittings with brazed joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

   A. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

   B. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

   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 according to 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.

L. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

M. 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.

N. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

O. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
   1. Shot blast the interior of piping.
   2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
   3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
   4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
   5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
   6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

Q. Identify refrigerant piping and valves according to 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 230517 "Sleeves and Sleeve Seals for HVAC Piping."

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

U. See Section 238129 Variable-Refrigerant-Flow HVAC Systems for additional requirements.

3.4 PIPE JOINT CONSTRUCTION

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 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. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

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.

E. See Section 238129 Variable-Refrigerant-Flow HVAC Systems for additional requirements.

3.5 HANGERS AND SUPPORTS

A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet 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.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:
1. NPS 1/2: Maximum span, 60 inches; minimum rod, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod, 1/4 inch.
3. NPS 1: Maximum span, 72 inches; minimum rod, 1/4 inch.
4. NPS 1-1/4: Maximum span, 96 inches; minimum rod, 3/8 inch.
5. NPS 1-1/2: Maximum span, 96 inches; minimum rod, 3/8 inch.

D. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2: Maximum span, 10 feet; minimum rod, 3/8 inch.

E. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform the following 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 shall maintain test pressure at the manifold gage 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.

B. Prepare test and inspection reports.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
2. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
3. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
B. Adjust set-point temperature of air-conditioning controllers to the system design temperature.

C. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
   1. Verify that compressor oil level is correct.
   2. Open refrigerant valves except bypass valves that are used for other purposes.

END OF SECTION 232300
SECTION 233113 - METAL DUCTS

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. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
4. Sealants and gaskets.
5. Hangers and supports.

1.3 SUBMITTALS

A. Product Data: For each type of the following products:

1. Sealants and gaskets.

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. Elevation of top of ducts.
4. Fittings.
5. Seam and joint construction.
6. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.4 QUALITY ASSURANCE


B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

C. Comply with the Mechanical Code of New York State.

D. Comply with the Energy Conservation Code of New York State.
PART 2 - PRODUCTS

2.1 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.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) 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."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," 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."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "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."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Lindab Inc.
   b. McGill AirFlow LLC.
   c. SEMCO Incorporated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," 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."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," 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 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 shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, 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.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, 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.

D. Solvent-Based Joint and Seam Sealant:
1. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
5. Solids Content: Minimum 60 percent.
7. Water resistant.
8. Mold and mildew resistant.
10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C 920.
1. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Type: S.
4. Grade: NS.
5. Class: 25.
6. Use: O.

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.5 HANGERS AND SUPPORTS
A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
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 according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts 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, plus allowance for insulation thickness.

H. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Boiler Room, Outside-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "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 thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches 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.

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.

3.4 CONNECTIONS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:
   2. Test the following systems:
      a. Outdoor Air Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, 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. Test for leaks before applying external insulation.
   5. 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.
   6. 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.

D. Duct system will be considered defective if it does not pass inspections.

E. Duct cleaning as specified below will be required if duct system does not pass cleanliness tests. Cleanliness tests will be repeated until acceptable cleanliness levels are achieved.

F. Prepare test and inspection reports.

3.6 DUCT CLEANING

A. Duct cleaning will be required only if duct system cleanliness tests are failed.

B. Clean new duct system(s) before testing, adjusting, and balancing.

C. Use service openings for entry and inspection.

D. Clean the following components by removing surface contaminants and deposits:
   
   1. Louvers
   2. Outside-air ducts and turning vanes.

3.7 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel.

B. Indoor Supply, Return, Exhaust, and Outside Air Ducts:
   
   1. Provide the following:
      
      a. Pressure Class: Positive or negative up to 2-inch wg.
      b. SMACNA Leakage Class for Rectangular: 16.
      c. SMACNA Leakage Class for Round: 8.

C. Intermediate Reinforcement:
   

D. Elbow Configuration:
   
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
      
      a. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
      b. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "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) Radius-to Diameter Ratio: 1.5.
   
   b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
   
   c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

END OF SECTION 233113
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:
      2. Control dampers.
      3. Flange connectors.
      4. Duct silencers.
      5. Turning vanes.
      6. Flexible connectors.
      7. Duct accessory hardware.
      8. Duct mounted access doors

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
      1. For duct silencers, include pressure drop and dynamic insertion loss 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.

1.4 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.
PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION


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 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60.
   2. Exposed-Surface Finish: Mill phosphatized.

B. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

C. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. American Warming and Ventilating; a Mestek Architectural Group company.
      b. McGill AirFlow LLC.
      c. Nailor Industries Inc.
      d. Ruskin Company.
      e. Vent Products Co., Inc.
   2. Standard leakage rating, with linkage outside airstream.
   3. Suitable for horizontal or vertical applications.
   4. Frames:
a. Frame: Hat-shaped, 0.094-inch-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, 0.064 inch thick.


7. Bearings:
a. Oil-impregnated bronze.
b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

2.4 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. American Warming and Ventilating; a Mestek Architectural Group company.
2. Arrow United Industries.
4. McGill AirFlow LLC.
5. Nailor Industries Inc.
6. Ruskin Company.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA’s Certified Ratings Seal for both air performance and air leakage.

C. Frames:

1. Hat shaped.
2. 0.094-inch-thick, galvanized sheet steel.
3. Mitered and welded corners.

D. Blades:

1. Multiple blade with maximum blade width of 6 inches.
2. Parallel-blade design.
4. 0.064 inch thick single skin or 0.0747-inch-thick dual skin.
E. **Blade Axles**: 1/2-inch-diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. **Operating Temperature Range**: From minus 40 to plus 200 deg F.

F. **Bearings**:

1. Oil-impregnated bronze.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.5 **FLANGE CONNECTORS**

A. **Manufacturers**: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Ductmate Industries, Inc.
2. Elgen Manufacturing.
3. Hardcast, Inc.

B. **Description**: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. **Material**: Galvanized steel.

D. **Gage and Shape**: Match connecting ductwork.

2.6 **DUCT SILENCERS**

A. **Manufacturers**: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. McGill AirFlow LLC.
2. Price Noise Control.
3. Ruskin Company.

B. **General Requirements**:

1. Factory fabricated.
2. **Fire-Performance Characteristics**: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
3. **Airstream Surfaces**: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
C. Shape:
   1. Rectangular straight with splitters or baffles.
   2. Round straight with center bodies or pods.
   3. Rectangular elbow with splitters or baffles.
   4. U or Z shaped with baffels.
   5. Rectangular transitional with splitters or baffles.

D. Rectangular Silencer Outer Casing: ASTM A 653/A 653M, G90, galvanized sheet steel, 0.034 inch thick.

E. Inner Casing and Baffles: ASTM A 653/A 653M, G90 galvanized sheet metal, 0.034 inch thick, and with 1/8-inch-diameter perforations.

F. Special Construction:
   1. High transmission loss to achieve STC 45.

G. Connection Sizes: Match connecting ductwork unless otherwise indicated.

H. Principal Sound-Absorbing Mechanism:
   1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
   2. Dissipative type with fill material.
      a. Fill Material: Moisture-proof nonfibrous material.
      b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.
   3. Lining: Mylar or Tedlar.

I. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
   1. Joints: continuously welded or flanged connections.
   2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
   3. Reinforcement: Cross or trapeze angles for rigid suspension.

J. Source Quality Control: Test according to ASTM E 477.
   1. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm face velocity.
   2. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.
2.7 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Aero-Dyne Sound Control Co.
2. Ductmate Industries, Inc.
3. Duro Dyne Inc.
4. Elgen Manufacturing.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.


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"; Figures 4-3, "Vanef and Vane Runners," and 4-4, "Vane Support in Elbows."

E. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.8 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. Ventfabrics, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.


1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.
   1. Minimum Weight: 24 oz./sq. yd..
   2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
   3. Service Temperature: Minus 50 to plus 250 deg F.

G. 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. Outdoor 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 movement at start and stop.

2.9 DUCT ACCESSORY HARDWARE

A. 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.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.10 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Air Balance Inc.; a division of Mestek, Inc.
   2. METALAIRE, Inc.
   3. Nailor Industries Inc.
   4. Ruskin Company.

   1. Door:
      a. Double wall, rectangular.
AIR DUCT ACCESSORIES

b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
d. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
   a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square: Continuous and two sash locks.

2.11 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. NCA Manufacturing, Inc.
   3. Ruskin Company.

B. Type: dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-in ch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed galvanized steel; with mitered and interlocking corners; gauge in accordance with UL listing.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel; gauge in accordance with UL listing.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, galvanized sheet steel; gauge in accordance with UL listing.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.


PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," 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 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.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated.

F. Install flexible connectors to connect ducts to equipment.

G. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

H. Install duct test holes where required for testing and balancing purposes.

I. Install fire dampers according to UL listing.

J. 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. Control devices requiring inspection.
   8. Elsewhere as indicated.

K. Install access doors with swing against duct static pressure.

L. Access Door Sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches
   2. Two-Hand Access: 12 by 6 inches
   3. Head and Hand Access: 18 by 10 inches
   4. Head and Shoulders Access: 21 by 14 inches
   5. Body Access: 25 by 14 inches
   6. Body plus Ladder Access: 25 by 17 inches Coordinate first paragraph below with Section 230553 "Identification for HVAC Piping and Equipment."
M. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect turning vanes for proper and secure installation.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.

END OF SECTION 233300
SECTION 233416 - CENTRIFUGAL HVAC FANS

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: For each product.

1. Updraft kitchen exhaust fan (existing)
2. Centrifugal roof ventilators.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Fan speed controllers.

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.
2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Indicate and certify field measurements.

1. Roof framing and support members relative to duct penetrations.

B. Field quality-control reports.

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.
1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Belts: One set(s) for each belt-driven unit.

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. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
   1. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

B. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

C. Belt Drives:
   1. Resiliently mounted to housing.
   2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   5. Fan and motor isolated from exhaust airstream.

D. Accessories:
   1. Variable-Speed 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 mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

E. Capacities and Characteristics: See Drawings.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

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.

B. Enclosure Type: Open, drip-proof.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install centrifugal fans level and plumb.

B. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

E. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

F. Lift and support units with manufacturer's designated lifting or supporting points.

G. Curb Support: Install roof curb on roof structure, level and secure, according to "The NRCA Roofing and Waterproofing Manual," Low-Slope Membrane Roofing Construction Details Section, Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install and secure centrifugal fans on curbs, and coordinate roof penetrations and flashing with roof construction. Secure units to curb support with anchor bolts.

H. Install units with clearances for service and maintenance.

I. Label fans according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."
3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. 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.
2. Verify that cleaning and adjusting are complete.
3. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. For belt-driven fans, reconnect fan drive system, align and adjust belts, and install belt guards.
4. Adjust damper linkages for proper damper operation.
5. Verify lubrication for bearings and other moving parts.
6. See Section 230593 "Testing, Adjusting, and Balancing For HVAC" for testing, adjusting, and balancing procedures.
7. Notify Owner of any malfunctioning units.

B. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

C. Lubricate bearings.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 233416
SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. In line cabinet fans.
2. In line booster fans.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Motor ratings and electrical characteristics, plus motor and electrical accessories.
3. Dampers, including housings, linkages, and operators.

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.
2. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include in operation and maintenance manuals.

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.
1.6 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of equipment supports, and connection to equipment.

PART 2 - PRODUCTS

2.1 HVAC POWER VENTILATORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Broan-NuTone LLC.
2. Carnes Company.
4. PennBarry.
6. Fantech (in-line booster fans).

2.2 IN-LINE CABINET FANS

A. Unit Description: Quiet running fan with permanent lubricated motor mounted with resilient mounts, UL listed. Equipped with integral junction box with disconnect switch, automatic back draft damper at fan discharge, variable speed control switch and accessory air terminal, where required.

1. Housing: Acoustically insulated, constructed of heavy gauge steel. Provided with adjustable mounting brackets for easy installation.

2. Inlet/Outlet: Aluminum inlet grille with clear lacquer finish where indicated on Drawings or straight through air flow, with inlet and outlet duct collars (without ceiling inlet grille) where indicated on Drawings. Integral back-draft damper.

B. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

C. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed.

D. Capacities and Characteristics: See Drawing Schedule.

2.3 IN-LINE BOOSTER FAN

A. Housing: Galvanized steel with a powder coat, baked enamel finish.
B. Fan: Backward inclined blades to allow particles to pass through fan.

C. Fan shall have comprehensive five (5) year warranty.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Support suspended units from structure using threaded steel rods and elastomeric hangers having a static deflection of 1 inch. Install units with clearances for service and maintenance.

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Install ducts adjacent to fans to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. 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.
3. Verify that cleaning and adjusting are complete.
4. Shut unit down and reconnect automatic temperature-control operators.
5. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Prepare test and inspection reports.

END OF SECTION 233423
SECTION 233533 - LISTED KITCHEN VENTILATION SYSTEM EXHAUST DUCTS

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. Listed grease ducts.

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 listed grease ducts.

B. Shop Drawings: For listed grease ducts.
   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.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
PART 2 - PRODUCTS

2.1 LISTED GREASE DUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. AMPCO Stacks.
2. McGill AirFlow LLC.
3. Metal-Fab, Inc.
4. Schebler Co. (The).
5. Selkirk Corporation.

B. Description: Factory-fabricated, -listed, and -labeled, double-wall ducts tested according to UL 1978 and rated for 500 deg F continuously, or 2000 deg F for 30 minutes; with positive or negative duct pressure and complying with NFPA 211.

C. Construction: Inner shell and outer jacket separated by at least a 1-inch annular space filled with high-temperature, ceramic-fiber insulation.

1. Inner Shell: ASTM A 666, Type 304 stainless steel.

D. Gaskets and Flanges: Ensure that gaskets and sealing materials are rated at 1500 deg F minimum.

E. Hood Connectors: Constructed from same material as grease duct with internal or external continuously welded or brazed joints.

F. Accessories: Tees, elbows, increasers, 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. Include unique components required to comply with NFPA 96 including cleanouts, transitions, adapters, and drain fittings.

G. Grease Duct Supports: Construct duct bracing and supports from non-combustible material.

1. Design bracing and supports to carry static and seismic loads within stress limitations of the International Building Code.
2. Ensure that bolts, screws, rivets and other mechanical fasteners do not penetrate duct walls.

H. Comply with ASTM E 2336.

I. Factory Tests: Test and inspect fire resistance of grease duct system according to ASTM E 2336.

1. Allow consultant two days' minimum notification before test is performed.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations

B. Coordinate connections to kitchen exhaust hoods with requirements in Section 233813 "Commercial-Kitchen Hoods."

C. Coordinate connections to exhaust fans with requirements in Section 233416 "Centrifugal HVAC Fans."

D. Comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211 and UL 2221, whichever is most stringent.

E. Seal between sections of grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.

F. Connections: Make grease duct connections according to the International Mechanical Code.

1. Grease duct to exhaust fan connections: Connect grease ducts to inlet side of fan using flanges, gaskets, and bolts.

2. Grease duct to hood connections:
   a. Make grease duct to hood joints connections using internal or external continuously welded or brazed joints.
   b. Make watertight grease duct to hood joints connections using flanges, gaskets, and bolts.

G. Support ducts at intervals recommended by manufacturer to support weight of ducts and accessories, without applying loading on kitchen hoods.

1. Securely attach supports and bracing to structure.

H. Repair damage to adjacent materials caused by listed kitchen ventilation system exhaust ducts installation.
3.3 FIELD QUALITY CONTROL

A. Perform air leakage test in presence of Owner before concealment of any portion of the grease duct system.

1. Notify Owner a minimum of two days before test is performed.

END OF SECTION 233533
SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Square Ceiling Diffusers.
   2. Adjustable Supply Grilles
   3. Eggcrates
   4. Fixed Face Return Grilles

1.3 SUBMITTALS

A. Product Data:  For each type of product indicated, include the following:
   1. Data Sheet:  Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule:  Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Coordination Drawings:  Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, 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.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Square Ceiling Supply Air Diffusers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Carnes.
   b. METALAIRE, Inc.
   c. Nailor Industries Inc.
   d. Titus.

2. Devices shall be specifically designed for variable-air-volume flows, louvered face with four cone drop design and round neck.
3. Material: Steel or aluminum as scheduled.
4. Finish: Baked enamel, white, unless otherwise scheduled.
5. Provide diffuser as scheduled on drawings.

2.2 REGISTERS AND GRILLES

A. Adjustable Supply Grille:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Carnes.
   b. Krueger.
   c. Nailor Industries Inc.
   d. Titus.

2. Material: Steel or aluminum as scheduled.
3. Finish: Baked enamel, white, unless otherwise noted.
4. Face Arrangement: Double deflection, horizontal blades in front, individually adjustable with blades; 1/2” or 3/4” spacing, as scheduled.
5. Mounting: Wall mounting with 1-1/4” flange frame.
6. Provide as scheduled on drawings.

B. Eggcrate:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Carnes.
   b. Krueger.
   c. Nailor Industries Inc.
   d. Titus.

2. Material: Extruded Aluminum with aluminum core or steel as scheduled.
3. 1/2 inch x 1/2 inch x 1/2inch deep squares on 45 deg deflection to prevent line of sight from below and with minimum 90% free area.
4. Flat frame to fit lay-in ceiling grid.
5. White baked enamel finish to match ceiling.
6. Neck size and accessories as noted on drawings.

C. Fixed Face Return Grille:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Carnes.
   b. Krueger.
   c. Nailor Industries Inc.
   d. Titus.

2. Material: Steel or aluminum as scheduled.
3. Finish: Baked enamel, white, unless otherwise noted.
4. Face Arrangement: Single deflection, horizontal Blades; 1/2” spacing or, as scheduled, at 35 degree blade setting.
5. Mounting: Wall mounting with steel frame for steel bodied registers or aluminum for aluminum bodied registers.
6. Provide as scheduled on drawings.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels,
locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713
SECTION 233723 - HVAC GRAVITY VENTILATORS

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. Roof hoods.
   2. Goosenecks.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For gravity ventilators. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
   1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof framing plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Structural members to which roof curbs and ventilators will be attached.
   2. Sizes and locations of roof openings.

1.5 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.

B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.

C. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 zinc coating, mill phosphatized.

D. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.
   1. Use types and sizes to suit unit installation conditions.
   2. Use Phillips flat or hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.

2.2 FABRICATION, GENERAL

A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.

D. Fabricate supports, anchorages, and accessories required for complete assembly.

E. Perform shop welding by AWS-certified procedures and personnel.

2.3 ROOF HOODS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   1. Acme Engineering & Manufacturing Corp.
   2. Greenheck Fan Corporation.
   3. Loren Cook Company.
   4. PennBarry.

B. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 6-6 and 6-7.
C. Materials: Aluminum sheet, minimum 0.063-inch-thick base and 0.050-inch-thick hood; suitably reinforced.

D. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch-thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Overall Height: See Drawing Details.

E. Bird Screening: Galvanized-steel, 1/2-inch-square mesh, 0.041-inch wire.

F. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch wire.

G. Galvanized-Steel Sheet Finish:

1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.
2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.


2.4 GOOSENECKS

A. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 6-5; with a minimum of 0.052-inch-thick, galvanized-steel sheet.

B. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch-thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Overall Height: See Drawing Details.

C. Bird Screening: Galvanized-steel, 1/2-inch-square mesh, 0.041-inch wire.

D. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch wire.

E. Galvanized-Steel Sheet Finish:

1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.
2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.

B. Install goosenecks on curb base where throat size exceeds 9 by 9 inches.

C. Install gravity ventilators with clearances for service and maintenance.

D. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 079200 "Joint Sealants" for sealants applied during installation.

F. Label gravity ventilators according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

G. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

H. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in Section 233113 "Metal Ducts". Drawings indicate general arrangement of ducts and duct accessories.

3.3 ADJUSTING

A. Adjust damper linkages for proper damper operation.

END OF SECTION 233723
SECTION 235533 - GAS-FIRED UNIT HEATERS

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 gas-fired unit heaters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of gas-fired unit heater.

1. Include rated capacities, operating characteristics, and accessories.

B. Shop Drawings: For gas-fired unit heaters. Include plans, elevations, sections, and attachment details.

1. Prepare by or under the supervision of a qualified professional engineer detailing fabrication and assembly of gas-fired unit heaters, as well as procedures and diagrams.
2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which equipment will be attached.
2. Items penetrating roof and the following:
   a. Vent and gas piping rough-ins and connections.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.
1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gas-fired unit heaters to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One for each belt-driven fan size.

1.7 QUALITY ASSURANCE

A. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace heat exchanger of gas-fired unit heater that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1. Modine Manufacturing Company.
2. REZNOR, a brand of Nortek Global HVAC.
3. Sterling HVAC Products; a Mestek company.
4. Trane.

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. Capacities and Characteristics: See Drawing Schedules.

2.2 MANUFACTURED UNITS

A. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.8/CSA 2.6.
B. Gas Type: Design burner for natural gas having characteristics same as those of gas available at Project site.

C. Type of Venting: Powered Indoor, separated combustion, power vented.

D. Housing: Steel, with integral draft hood and inserts for suspension mounting rods.
   1. External Casings and Cabinets: Baked enamel or powder coating over corrosion-resistant-treated surface.

E. Accessories:
   1. Four-point suspension kit.
   2. Power Venter: Centrifugal aluminized-steel fan, with stainless-steel shaft; 120-V ac motor.
   3. Concentric, Terminal Vent Assembly: Combined combustion-air inlet and power-vent outlet with wall or roof caps. Include adapter assembly for connection to inlet and outlet pipes, and flashing for wall or roof penetration.


H. Propeller Unit Fan:
   1. Aluminum propeller blades riveted to heavy-gage steel spider bolted to cast-iron hub, dynamically balanced, and resiliently mounted.
   2. Fan-Blade Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.

I. Centrifugal Unit Fan:
   1. Steel, centrifugal fan dynamically balanced and resiliently mounted.
   2. Belt-Driven Drive Assembly:
      a. Resiliently mounted to housing, with the following features:
         1) Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
         2) Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
         3) Pulleys: Cast-iron, adjustable-pitch motor pulley.

J. Motors:
   1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   2. Enclosure Materials: Rolled steel.
K. Controls: Regulated redundant gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

1. Gas Control Valve: Single stage.
2. Ignition: Electronically controlled electric spark with flame sensor.
3. Fan Thermal Switch: Operates fan on heat-exchanger temperature.
5. Control transformer.
6. High Limit: Thermal switch or fuse to stop burner.
7. Wall-Mounted Thermostat:
   a. Single stage.
   b. Fan on-off-automatic switch.
   c. 24-V ac.
   d. 50 to 90 deg F operating range.

L. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and connect gas-fired unit heaters and associated gas and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written instructions.

3.2 EQUIPMENT MOUNTING

A. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

1. Threaded Rods, Spring Hangers, and Building Attachments: Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" and Section 230548 "Vibration and Seismic Controls for HVAC."
2. Anchor the unit to resist code-required horizontal acceleration.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to gas-fired unit heater, allow space for service and maintenance.

C. Gas Piping: Comply with Section 231123 "Facility Natural-Gas Piping." Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.
D. Vent Connections: Comply with Section 235123 "Gas Vents."

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."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. 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.

C. Gas-fired unit heater will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain gas-fired unit heaters.

END OF SECTION 235533
SECTION 236200 - PACKAGED COMPRESSOR AND CONDENSER UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes packaged, refrigerant compressor and condenser units.

1.3 ACTION SUBMITTALS

A. Product Data: For each compressor and condenser unit. Include rated capacities, operating
characteristics, and furnished specialties and accessories. Include equipment dimensions,
weights and structural loads, required clearances, method of field assembly, components, and
location and size of each field connection.

B. Shop Drawings: For compressor and condenser units. Include plans, elevations, sections,
details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and
coordinated with each other, based on input from installers of the items involved:

1. Structural members to which compressor and condenser units will be attached.
2. Liquid and vapor pipe sizes.
3. Refrigerant specialties.
4. Piping including connections, oil traps, and double risers.
5. Compressors.

B. Field quality-control reports.

C. Warranty: Sample of special warranty.
1.5 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For compressor and condenser units to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   B. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Standard for Refrigeration Systems."
   C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."
   D. ASME Compliance: Fabricate and label water-cooled compressor and condenser units to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.7 COORDINATION
   A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases. Coordinate location of piping and electrical rough-ins.

1.8 WARRANTY
   A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of compressor and condenser units that fail in materials or workmanship within specified warranty period.
      1. Failures include, but are not limited to, the following:
         a. Compressor failure.
         b. Condenser coil leak.
      2. Warranty Period: Five years from date of Substantial Completion.
      3. Warranty Period (Compressor Only): Five years from date of Substantial Completion.
      4. Warranty Period (Components Other Than Compressor): Five years from date of Substantial Completion.
      5. Warranty Period (Condenser Coil Only): Five years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 COMPRESSOR AND CONDENSER UNITS, AIR COOLED, 1 TO 5 TONS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Mitsubishi
2. Trane
3. Carrier Corporation; a unit of United Technologies Corp.

B. Description: Factory assembled and tested; consisting of compressor, condenser coil, fan, motors, refrigerant reservoir, and operating controls.

C. Compressor-Condenser Components:

1. 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.
2. 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.
   a. Compressor Type: Scroll.
   b. Inverter driven compressor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
   c. Electronic linear expansion valves for refrigerant metering.
   d. Refrigerant Charge: R-410A.
   e. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
3. Fan: Aluminum-propeller type, directly connected to motor.

D. Refrigerant: R-410A.

E. Condenser Coil: Seamless copper-tube, aluminum-fin coil; circuited for integral liquid subcooler, with removable drain pan and brass service valves with service ports.

F. Condenser Fan: Direct-drive, aluminum propeller fan; with permanently lubricated, totally enclosed fan motor with thermal-overload protection.

G. Accessories:

2. Evaporator Freeze Thermostat: Temperature-actuated switch that stops unit when evaporator reaches freezing temperature.
3. Filter-dryer.
4. High-Pressure Switch: Automatic-reset switch cycles compressor off on high refrigerant pressure.
5. Low-Pressure Switch: Automatic-reset switch cycles compressor off on low refrigerant pressure.
6. PE mounting base.
7. Precharged and insulated suction and liquid tubing.

H. 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 gage ports on exterior of casing.

I. Capacities and Characteristics: See Drawings

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

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.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate compressor and condenser units according to ARI 206/110.


C. Test and inspect shell and tube condensers according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

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. Maintain manufacturer's recommended clearances for service and maintenance.

C. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

A. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

B. Connect precharged refrigerant tubing to unit's quick-connect fittings. Install tubing so it does not interfere with access to unit. Install furnished accessories.

C. 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."

D. Connect refrigerant and condenser-water piping to water-cooled compressor and condenser units. Maintain clear tube removal space. Refrigerant piping and specialties are specified in Section 232300 "Refrigerant Piping."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.

B. 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 proper airflow over coils.

C. Verify that vibration isolation and flexible connections properly dampen 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.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions 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. Lubricate bearings on fan motors.

C. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.

D. Adjust fan belts to proper alignment and tension.

E. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.

F. Measure and record airflow and air temperature rise over coils.

G. Verify proper operation of condenser capacity control device.

H. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

I. After startup and performance test, lubricate bearings.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain compressor and condenser units.
SECTION 237416 - PACKAGED, LARGE-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes packaged, large-capacity, rooftop air conditioning units (RTUs) with the following components and accessories:

1. Casings.
2. Fans.
3. Motors.
5. Refrigerant circuit components.
6. Air filtration.
7. Gas furnaces.
8. Dampers.
9. Electrical power connections.
10. Controls.
11. Accessories.
12. Roof curbs.

1.3 DEFINITIONS

A. DDC: Direct-digital controls.

B. ECM: Electronically commutated motor.

C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

D. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, large-capacity, rooftop air-conditioning units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

E. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
F. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.4 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, 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.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Structural members to which RTUs will be attached.
   2. Roof openings.
   3. Roof curbs and flashing.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fan Belts: One set(s) for each belt-driven fan.
   2. Filters: One set(s) of filters for each unit.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of RTUs that fail in materials or workmanship within specified warranty period.
1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than ten years from date of Substantial Completion.
3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
4. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. AHRI Compliance:
   1. Comply with AHRI 340/360 for testing and rating energy efficiencies for RTUs.
   2. Comply with AHRI 270 for testing and rating sound performance for RTUs.
   3. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs.

B. AMCA Compliance:
   1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
   2. Damper leakage tested in accordance with AMCA 500-D.
   3. Operating Limits: Classify according to AMCA 99.

C. ASHRAE Compliance:
   1. Comply with ASHRAE 15 for refrigeration system safety.
   2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
   3. Comply with 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. NFPA Compliance: Comply with NFPA 90A or NFPA 90B.


G. 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 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. AAON.
2. Trane.
3. Valent.

2.3 CAPACITIES AND CHARACTERISTICS: See Drawing Schedules for performance criteria.

A. Motors:
   1. Service Factor: 1.15.

2.4 CASINGS

A. General Fabrication Requirements for Casings: Formed and reinforced insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

C. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
   1. Materials: ASTM C 1071, Type I.
   2. Thickness: 1 inch.
   3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
   4. Liner Adhesive: Comply with ASTM C 916, Type I.

D. Condensate Drain Pans: Fabricated using stainless 0.025 inches thick steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1 for design and construction of drain pans.
   1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
   2. Drain Connections: Threaded nipple.

E. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.5 FANS

A. Supply-Air Fans: Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
   1. Belt-Driven Supply-Air Fans: Motors shall be installed on an adjustable fan base resiliently mounted in the casing.
B. Condenser-Coil Fan: propeller, mounted on shaft of permanently lubricated multispeed ECM motors.

2.6 COILS

A. Supply-Air Refrigerant Coil:
   1. Copper-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
   2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.

2.7 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits: As Scheduled.
B. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief.
C. Refrigeration Specialties:
   1. Refrigerant: R-410A.
   2. Expansion valve with replaceable thermostatic element.
   3. Refrigerant filter/dryer.
   5. Automatic-reset low-pressure safety switch.
   8. Brass service valves installed in compressor suction and liquid lines.

2.8 AIR FILTRATION

A. Minimum arrestance and a minimum efficiency reporting value according to ASHRAE 52.2.
B. Flat Panel Filters:
   1. Description: Factory-fabricated, self-supported, flat, nonpleated, panel-type, disposable air filters with holding frames.
   2. Filter Unit Class: UL 900, Class 1.
   3. Media: Interlaced glass or synthetic fibers coated with nonflammable adhesive.
      a. Adhesive: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.
b. Adhesive: 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."

c. Metal Retainer: Upstream side and downstream side.

2.9 GAS FURNACES

A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47/CSA 2.3 and NFPA 54.

1. CSA Approval: Designed and certified by and bearing label of CSA.

B. Burners: Dual-stage stainless steel.

1. Fuel: Natural gas.
2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.

C. Heat-Exchanger and Drain Pan: Aluminized steel and stainless steel.

D. Venting: power vented.

E. Safety Controls:

1. Gas Control Valve: Modulating.

2.10 DAMPERS

A. Outdoor-Air Damper: Linked damper blades, for 0 to 100 percent outdoor air dry-bulb economizer, with motorized damper filter.

2.11 ELECTRICAL POWER CONNECTIONS

A. RTU shall have a single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.12 CONTROLS

A. Basic Unit Controls:

1. Control-voltage transformer.
2. Unit-Mounted Annunciator Panel for Each Unit:
a. Lights to indicate power on, cooling, heating, fan running, filter dirty, and unit alarm or failure.
b. Local, 7-day programmable thermostat.

2.13 ACCESSORIES

A. Non-powered, duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.

B. Remote potentiometer to adjust minimum economizer damper position.

C. Barometric relief air damper.

D. Safeties:
   1. Smoke detector.
   2. Condensate overflow switch.
   3. High and low pressure control.
   5. Discharge air, return air, and outdoor air temperature sensors.
   6. HACR circuit breaker/disconnect
   7. Dirty filter indicator switch.
   8. Phase monitor.
   9. Galvanized steel drain pan.
  10. Barometric relief-air damper with hood kit.

E. Outdoor air intake weather hood.

2.14 ROOF CURBS

A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

   1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
      a. Materials: ASTM C 1071, Type I or II.
      b. Thickness: 2 inch.

   2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
      a. Liner Adhesive: Comply with ASTM C 916, Type I.
      b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.

d. Liner Adhesive: Comply with ASTM C 916, Type I.

B. Curb Dimensions: Height of 14 inches, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

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

3.2 INSTALLATION

A. Roof Curb: Install on roof structure, level and secure, according to NRCA's "NRCA Roofing Manual: Membrane Roof Systems." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

B. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.

C. Equipment Mounting:

1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3.3 CONNECTIONS

A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

B. Install piping adjacent to RTUs to allow service and maintenance.

1. Gas Piping: Comply with applicable requirements in Section 231123 "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
C. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.
5. Install normal-weight, 3000-psi, compressive strength (28-day) concrete mix inside roof curb, 4 inches thick. Concrete, formwork, and reinforcement are specified with concrete.

D. Connect electrical wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. 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 as layers of black with engraved white letters at least 1/2-inch high.
3. Locate nameplate where easily visible.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. RTU will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.
3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions.

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to furnace combustion chamber.
3. Inspect for visible damage to compressor, coils, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Remove packing from vibration isolators.
13. Inspect operation of barometric relief dampers.
14. Verify lubrication on fan and motor bearings.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Adjust fan belts to proper alignment and tension.
17. Start unit according to manufacturer's written instructions.
   a. Start refrigeration system.
   b. Do not operate below recommended low-ambient temperature.
   c. Complete startup sheets and attach copy with Contractor's startup report.
18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.
20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
   a. Measure gas pressure on manifold.
   b. Inspect operation of power vents.
   c. Measure combustion-air temperature at inlet to combustion chamber.
   d. Measure flue-gas temperature at furnace discharge.
   e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
   f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
22. Adjust and inspect high-temperature limits.
23. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
24. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
   a. Coil leaving-air, dry- and wet-bulb temperatures.
b. Coil entering-air, dry- and wet-bulb temperatures.
c. Outdoor-air, dry-bulb temperature.
d. Outdoor-air-coil, discharge-air, dry-bulb temperature.

25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.

26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
   a. Supply-air volume.
   b. Return-air volume.
   c. Relief-air volume.
   d. Outdoor-air intake volume.

27. Simulate maximum cooling demand and inspect the following:
   a. Compressor refrigerant suction and hot-gas pressures.
   b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

28. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
   b. Low-temperature safety operation.
   c. Filter high-pressure differential alarm.
   d. Economizer to minimum outdoor-air changeover.
   e. Relief-air fan operation.
   f. Smoke and firestat alarms.

29. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

A. 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.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs.
PACKAGED, LARGE-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS
SECTION 237423 - INDIRECT-FIRED, OUTDOOR, HEATING-ONLY AIR HANDLING UNITS

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section includes indirect-fired makeup-air units.

1.3 DEFINITIONS
   A. BAS: Building automation system.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type and configuration of outdoor, indirect-fired makeup-air unit.
      1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   B. Shop Drawings: For each type and configuration of outdoor, indirect-fired heating and ventilating unit.
      1. Prepared by or under the supervision of a qualified professional engineer.
      2. Include plans, elevations, sections, and mounting details.
      3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      4. Detail fabrication and assembly of gas-fired heating and ventilating units, as well as procedures and diagrams.
      5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
      6. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS
   A. Startup service reports.
   B. Sample Warranty: For manufacturer's special warranty.
1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For indirect-fired makeup-air units to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set(s) for each unit.
2. Fan Belts: One set(s) for each unit.

1.8 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Units shall be ETL and IRI listed.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of indirect-fired heating and ventilating units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than ten years from date of Substantial Completion.

2. Warranty Period for Units: Manufacturer's standard, but not less than one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Reznor/Thomas & Betts Corporation.
2. Sterling HVAC Products.
3. Trane Inc.
4. Greenheck
2.2 SYSTEM DESCRIPTION

A. Factory-assembled, prewired, self-contained unit consisting of cabinet, supply fan, controls, filters, and indirect-fired gas burner to be installed exterior to the building.

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.

2.3 UNIT CASINGS

A. General Fabrication Requirements for Casings:

1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
2. Casing Joints: Sheet metal screws or pop rivets, factory sealed with water-resistant sealant.
3. Factory Finish for Galvanized-Steel Casings: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on enamel finish, consisting of prime coat and thermosetting topcoat.

B. Configuration: See Drawings for configuration.

C. Cabinet: Aluminized- or galvanized-steel panels formed to ensure rigidity and supported by galvanized-steel channels or structural channel supports with lifting lugs. Duct flanges at inlet and outlet. Pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

D. Outer Casing: 0.0598-inch- thick steel with heat-resistant, baked-enamel.

E. Inner Casing:

1. Burner Section Inner Casing: 0.0299-inch- thick steel.
2. Double-wall casing with inner wall of perforated or solid steel.
3. Internal Insulation: Fibrous-glass duct lining, neoprene coated, comply with ASTM C 1071, Type II, applied on complete unit.
   a. Thickness: 2 inches.
   b. Insulation Adhesive: Comply with ASTM C 916, Type I.
   c. Density: 1.5 lb/cu. ft..
   d. Mechanical Fasteners: Galvanized steel suitable for adhesive, mechanical, or welding attachment to casing without damaging liner when applied as recommended by manufacturer and without causing air leakage.

F. Discharge Section:

   a. Leakage: Low leakage.
2. Trapezoidal cowls with horizontal louvers.

G. Inspection and Access Panels and Access Doors:

1. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.

2. Access Doors:
   a. 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.
   b. Gasket: Neoprene, applied around entire perimeters of panel frames.
   c. Fabricate windows indoors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
   d. Size: At least 18 inches wide by full height of unit casing up to a maximum height of 60 inches.

3. Locations and Applications:
   a. Fan Section: Doors.
   b. Coil Section: Inspection and access panels.
   c. Damper Section: Inspection and access panels or doors.
   d. Filter Section: Inspection and access panels or doors large enough to allow periodic removal and installation of filters.

2.4 ACCESSORIES

A. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

2.5 OUTDOOR-AIR INTAKE HOOD

A. Type: Manufacturer's standard hood or louver.
B. Materials: Match cabinet.
C. Bird Screen: Comply with requirements in ASHRAE 62.1.
D. Aluminum mesh filter.

2.6 ROOF CURBS

A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
   a. Materials: ASTM C 1071, Type I or Type II.
   b. Thickness: 1 inch.
2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
   a. Liner Adhesive: Comply with ASTM C 916, Type I.
   b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
   c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.

B. Curb Height: 14 inches minimum, unless otherwise noted.

C. Wind: Metal brackets compatible with the curb and casing, painted to match unit, used to anchor unit to the curb, and designed for loads at Project site.

2.7 SUPPLY-AIR FAN

A. Fan Type: Centrifugal, rated according to AMCA 210; statically and dynamically balanced, galvanized steel; mounted on solid-steel shaft with heavy-duty, self-aligning, permanently lubricated ball bearings, pillow-block bearings. Bearing rating: L10 of 150,000 hours.

B. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly.

C. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with spring isolators.

D. Fan-Shaft Lubrication Lines: Extended to a location outside the casing.

E. Provide VFD drive for balancing purposes; system shall be constant volume.

2.8 AIR FILTERS

A. Disposable Panel Filters: Factory-fabricated, flat-panel-type, disposable air filters with holding frames, with a MERV 6 according to ASHRAE 52.2.
   1. Thickness: 2 inches.
   3. Frame: Galvanized steel.

2.9 DAMPERS

A. Outdoor-Air and Exhaust-Air Damper: Galvanized-steel, opposed-blade dampers with vinyl blade seals and stainless-steel jamb seals, having a maximum leakage of 10 cfm/sq. ft. of damper area, at a differential pressure of 2-inch wg.
B. Damper Operator: Direct coupled, electronic with spring return or fully modulating as required by the control sequence.

2.10 INDIRECT-FIRED GAS BURNER


1. CSA Approval: Designed and certified by and bearing label of CSA.
   a. Gas Control Valve: 4:1 modulating.
   b. Fuel: Natural gas.
   c. Minimum Combustion Efficiency: 80 percent.
   d. Ignition: Electronically controlled electric spark with flame sensor.

B. Venting: Power vented:


C. Combustion-Air Intake: Separate combustion-air intake and vent terminal assembly.

D. Heat Exchanger: Stainless steel.

E. Heat-Exchanger Drain Pan: Stainless steel.

F. Safety Controls:

2. Control Transformer: 24-V ac.
3. High Limit: Thermal switch or fuse to stop burner.
5. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
7. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
8. 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.
9. DDC-assisted furnace commissioning.

2.11 UNIT CONTROL PANEL

A. Factory-wired, fuse-protected control transformer, and connection for single-point power supply.
2.12 CONTROLS

A. Comply with requirements in Section 230900 "Instrumentation and Control for HVAC" and drawings for control equipment and sequence of operation.

B. Control Devices:
   1. Control-voltage transformer.
   2. Fire-Protection Thermostats: Fixed or adjustable settings to operate at not less than 75 deg F above normal maximum operating temperature.
   3. Heating Inlet Air Sensor
   4. Dirty Filter Switch
   5. Freeze protection (Supply Air Low Limit)

C. Temperature Control: Provide factory control of gas valves so that it will receive an input for electronic modulating 4-20 mA or 0-10 VDC signal for gas valve control by a local thermostat.

2.13 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

   1. Enclosure: Open, dripproof.
   3. Efficiency: Premium efficient, inverter duty rated.
   4. NEMA Design: Standard.
   5. Service Factor: 1.15.

2.14 CAPACITIES AND CHARACTERISTICS: See Drawing Schedules.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Verify cleanliness of airflow path to include inner-casing surfaces, filters, coils, turning vanes, fan wheels, and other components.

D. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 INSTALLATION

A. Equipment Mounting:
   1. Comply with requirements for vibration isolation devices specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Unit Support: Provide curb adaptor for mounting on existing curb to use current roof openings as indicated on Drawings. Coordinate roof penetrations and flashing with roof construction. Insulate, seal and flash curbs as indicated on drawings to provide a weather-tight installation.

C. Install heating and ventilating unit level. Secure units to structural support with anchor bolts.

D. Install gas-fired units according to NFPA 54, "National Fuel Gas Code."

E. Install controls and equipment shipped by manufacturer for field installation with indirect-fired heating and ventilating units.

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.
   1. Gas Piping: Comply with requirements in Section 231123 "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. Duct Connections: Connect supply and return ducts to indirect-fired heating and ventilating units with flexible duct connectors. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Units will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.
3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for visible damage to burner combustion chamber.
2. Inspect casing insulation for integrity, moisture content, and adhesion.
3. Verify that clearances have been provided for servicing.
4. Verify that controls are connected and operable.
5. Verify that filters are installed.
6. Purge gas line.
7. Inspect and adjust vibration isolators.
8. Verify bearing lubrication.
9. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
10. Adjust fan belts to proper alignment and tension.

C. Start unit according to manufacturer's written instructions.

1. Complete startup sheets and attach copy with Contractor's startup report.
2. Inspect and record performance of interlocks and protective devices; verify sequences.
3. Operate unit for run-in period recommended by manufacturer.
4. 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.
5. Calibrate thermostats.
6. Adjust and inspect high-temperature limits.
7. Inspect dampers, if any, for proper stroke and interlock with return-air dampers.
8. Inspect controls for correct sequencing of heating, and normal and emergency shutdown.
9. Measure and record airflow. Plot fan volumes on fan curve.
10. Verify operation of remote panel, including pilot-operation and failure modes. Inspect the following:
    a. High-limit heat.
    b. Alarms.
11. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
13. Verify outdoor-air damper operation.
3.6 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain heating and ventilating units.

END OF SECTION 237423
SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

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 split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

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.

2.  Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.  Filters: One set(s) for each air-handling unit.
1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 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: One year(s) from date of Substantial Completion.
   b. For Parts: One year(s) from date of Substantial Completion.
   c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Carrier Corporation, a unit of United Technologies Corp.
2. Mitsubishi Electric & Electronics USA, Inc.
3. LG Electronics.
2.2 INDOOR UNITS (5 TONS OR LESS)

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner.
4. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; with a two-position control valve.
6. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
7. Fan Motors:
   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
   c. Wiring Terminations: Connect motor to chassis wiring with plug connection.
8. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
10. Condensate Drain Pans:
   a. Fabricated with one 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.
   b. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
   c. Drain Connection: Located at lowest point of pan and sized to prevent overflow.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. 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.
2. 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.
a. Compressor Type: Scroll.
b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
c. Refrigerant Charge: R-410A.
d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.

3. Fan: Aluminum-propeller type, directly connected to motor.

2.4 ACCESSORIES

A. 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."

B. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
   1. Compressor time delay.
   2. 24-hour time control of system stop and start.
   3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
   4. Fan-speed selection including auto setting.

C. Automatic-reset timer to prevent rapid cycling of compressor.

D. 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.

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. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

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 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. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
   1. Leak Test: After installation, 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.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126
SECTION 238129 - VARIABLE-REFRIGERANT-FLOW HVAC SYSTEMS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes complete VRF HVAC system(s) including, but not limited to the following components to make a complete operating system(s) according to requirements indicated:
   1. Indoor Units
      a. Recessed, ceiling-mounted units (ceiling cassette units).
      b. Unit Ventilators: See Section 238223 – Unit Ventilators.
   2. Outdoor Units.
   4. System refrigerant.
   5. System refrigerant piping.
   6. Piping and tubing insulation.
   7. System control cable and raceways.

B. For Unit Ventilator VRF units, see Specification Section 238223 – Unit Ventilators

1.3 DEFINITIONS
A. Air-Conditioning System Operation: System capable of operation with all zones in cooling only.
B. Heat-Pump System Operation: System capable of operation with all zones in either heating or cooling, but not with simultaneous heating and cooling zones that transfer heat between zones.
C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
D. Two-Pipe System Design: One refrigerant vapor line and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One refrigerant liquid line and refrigerant vapor line connect HRCUs to associated indoor units. HRCUs used in two pipe systems act as an intermediate heat exchanger and include diverting valves and gas/liquid separators to move high and low pressure refrigerant between indoor units.
E. VRF: Variable refrigerant flow.
1.4 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 indoor and outdoor units.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   3. Include operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.
   4. Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.
   5. Include system operating sequence of operation in narrative form for each unique indoor- and outdoor-unit control.
   6. Include description of control software features.
   7. Include total refrigerant required and a comprehensive breakdown of refrigerant required by each system installed.
   8. Include refrigerant type and data sheets showing compliance with requirements indicated.

B. Shop Drawings: For VRF HVAC systems.
   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. 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.
   4. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.
   5. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittals:
   1. Include design calculations with corresponding diagram of refrigerant piping and tubing sizing for each system installed.
   2. Include design calculations with corresponding floor plans indicating that refrigerant concentration limits are within allowable limits of ASHRAE 15 and governing codes.
   3. Include calculations showing that system travel distance for refrigerant piping and controls cabling are within horizontal and vertical travel distances set by manufacturer.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, sections, and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Suspended ceiling components.
2. Structural floors, roofs and associated members to which equipment, piping, cables, and conduit will be attached.
3. Size and location of initial access modules for acoustical tile.
4. Wall-mounted controllers located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.
5. Size and location of access doors and panels installed behind walls and inaccessible ceilings for products installed behind walls and requiring access.

B. Qualification Data:

1. For Installer: Certificate from VRF HVAC system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
   a. Retain copies of Installer certificates on-site and make available on request.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VRF HVAC systems to include in emergency, operation, and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On CD or DVD, USB media, or approved cloud storage platform, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters:
   a. One set(s) for each unit with replaceable filters.
   b. One set(s) for each unit type and unique size of washable filters.
2. Indoor Units: One for each unique size and type installed.
3. Controllers for Indoor Units: One for each unique controller type installed.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Nationally recognized manufacturer of VRF HVAC systems and products.
2. Shipped VRF HVAC systems with similar requirements to those indicated for a continuous period of five years within time of bid.
3. VRF HVAC systems and products that have been successfully tested and in use on at least three completed projects.
4. Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use.

B. Factory-Authorized Service Representative Qualifications:

1. Authorized representative of, and trained by, VRF HVAC system manufacturer.
2. Demonstrated past experience with products being installed for period within three consecutive years before time of bid.
3. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
4. Service and maintenance staff assigned to support Project during warranty period.
5. Product parts inventory to support ongoing system operation for a period of not less than five years after Substantial Completion.
6. VRF HVAC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

C. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.

1. Each employee shall be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
2. Installer certification shall be valid and current for duration of Project.
3. Retain copies of Installer certificates on-site and make available on request.
4. Each person assigned to Project shall have demonstrated past experience.

D. ISO Compliance: System equipment and components furnished by VRF HVAC system manufacturer shall be manufactured in an ISO 9001 and ISO 14001 facility.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean and dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

E. Replace installed products damaged during construction.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures.
   b. Faulty operation.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period:
   a. For Compressor: Five year(s) from date of Substantial Completion.
   b. For Parts, Including Controls: Five year(s) from date of Substantial Completion.
   c. For Labor: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Carrier Corporation; a unit of United Technologies Corp.
2. LG Electronics.
3. Mitsubishi Electric & Electronics USA, Inc.
4. Trane Company (The).

B. Source Limitations: Obtain products from single source from single manufacturer including, but not limited to, the following:

1. Indoor and outdoor units, including accessories.
2. Controls and software.
3. Refrigerant isolation valves.

2.2 SYSTEM DESCRIPTION

A. Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, outdoor unit(s), piping,
controls, and electrical power to make complete operating system(s) complying with requirements indicated.

1. Two-pipe system design.
2. System(s) operation, air-conditioning or heat pump as indicated on Drawings.
3. Each system with one refrigerant circuit shared by all indoor units connected to system.

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. AHRI Compliance: System and equipment performance certified according to AHRI 1230 and products listed in AHRI directory.

D. ASHRAE Compliance:
   1. ASHRAE 15: For safety code for mechanical refrigeration.
   2. ASHRAE 62.1: For indoor air quality.
   3. ASHRAE 135: For control network protocol with remote communication.
   4. ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.

E. UL Compliance: Comply with UL 1995.

2.3 PERFORMANCE REQUIREMENTS

A. System Auto Refrigerant Charge: Each system shall have an automatic refrigerant charge function to ensure the proper amount of refrigerant is installed in system.

B. Outdoor Conditions:
   1. Suitable for outdoor ambient conditions encountered.
      a. Design equipment and supports to withstand wind loads of governing code and ASCE/SEI 7.
      b. Design equipment and supports to withstand snow and ice loads of governing code and ASCE/SEI 7.

C. Seismic Performance: VRF HVAC system(s) shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."
   2. Component Importance Factor: 1.5.
      a. SDS: 0.145g as per ASCE 7-10 Section 11.4.4
      b. SD1: 0.087g as per ASCE 7-10 Section 11.4.4

2.4 INDOOR UNITS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.
B. Cabinet:
1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
2. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
3. Mounting: Manufacturer-designed provisions for field installation.

C. DX Coil Assembly:
1. Coil Casing: Aluminum, galvanized, or stainless steel.
2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance.
4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5. Internal Tubing: Copper tubing with brazed joints.
6. Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7. Field Piping Connections: Manufacturer's standard.
8. Factory Charge: Dehydrated air or nitrogen.
9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:
1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
   a. Integral reservoir and control with electrical power connection through unit power.
3. Field Piping Connection: Non-ferrous material with threaded NPT.

E. Fan and Motor Assembly:
1. Fan(s):
   a. Direct-drive arrangement.
   b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
   c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
   d. Wheels statically and dynamically balanced.
2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5. Vibration Control: Integral isolation to dampen vibration transmission.
F. Filter Assembly:
   1. Access: Replacement without the need for tools.
   2. Media:
      a. Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.

G. Discharge-Air Grille and Return Assembly
   1. Ceiling Cassette Unit:
      a. Discharge mounted in bottom of unit cabinet.
         1) Discharge Pattern: four-way throw unless indicated on Drawings.
         2) Discharge Pattern Adjustment: Field-adjustable limits for up and down range of motion.
         3) Discharge Pattern Closure: Ability to close individual discharges of units with multiple patterns.
         4) Motorized Vanes: Modulating up and down flow pattern for uniform room air distribution.
      b. Return-Air Grille Assembly: Manufacturer's standard grille mounted in bottom of unit cabinet.

H. Unit Controls:
   1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
   2. Factory-Installed Controller: Configurable digital control.
   3. Field-Customizable I/O Capability:
   4. Communication: Network communication with other indoor units and outdoor unit(s).
   5. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
   6. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

I. Unit Electrical:
   1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
   2. Field Connection: Single point connection to power entire unit and integral controls.
   3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
   4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
   5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
2.5 OUTDOOR, AIR-SOURCE HEAT-PUMP UNITS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1. Specially designed for use in systems with either all heating or all cooling demands, but not for use in systems with simultaneous heating and cooling.
2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.

B. Cabinet:

1. Galvanized steel and coated with a corrosion-resistant finish.
   a. Coating with documented salt spray test performance of 1000 hours according ASTM B117 surface scratch test (SST) procedure.
2. Mounting: Manufacturer-designed provisions for field installation.
3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Compressor and Motor Assembly:

1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to 15 percent of rated capacity.
2. Protection: Integral protection against the following:
   a. High refrigerant pressure.
   b. Low oil level.
   c. High oil temperature.
   d. Thermal and overload.
   e. Voltage fluctuations.
   f. Phase failure and phase reversal.
   g. Short cycling.
3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
5. Oil management system to ensure safe and proper lubrication over entire operating range.
6. Crankcase heaters with integral control to maintain safe operating temperature.
7. Fusible plug.

D. Condenser Coil Assembly:

1. Plate Fin Coils:
   a. Casing: Aluminum, galvanized, or stainless steel.
   b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
c. Tubes: Copper, of diameter and thickness required by performance.

2. Aluminum Microchannel Coils:
   b. Single- or multiple-pass arrangement.
   c. Construct fins, tubes, and header manifolds of aluminum alloy.

3. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

E. Condenser Fan and Motor Assembly:
   1. Fan(s): Propeller type.
      a. Direct-drive arrangement.
      b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.
      c. Statically and dynamically balanced.
   2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.
   3. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
   5. Speed Settings and Control: Variable speed with a speed range of least 75 percent.

F. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

G. Unit Controls:
   1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
   2. Factory-Installed Controller: Configurable digital control.
   3. Factory-Installed Sensors:
      a. Refrigerant suction temperature.
      b. Refrigerant discharge temperature.
      c. Outdoor air temperature.
      d. Refrigerant high pressure.
      e. Refrigerant low pressure.
      f. Oil level.
   4. Communication: Network communication with indoor units and other outdoor unit(s).
   5. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
   6. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
H. Unit Electrical:
   1. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.
   2. Field Connection: Single point connection to power entire unit and integral controls.
   3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
   4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
   5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

I. Unit Hardware: Zinc-plated steel, or stainless steel. Coat exposed surfaces with additional corrosion-resistant coating if required to prevention corrosion when exposed to salt spray test for 1000 hours according ASTM B117.

J. Unit Piping:
   1. Unit Tubing: Copper tubing with brazed joints.
   2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
   3. Field Piping Connections: Manufacturer's standard.
   4. Factory Charge: Dehydrated air or nitrogen.
   5. Testing: Factory pressure tested and verified to be without leaks.

2.6 SYSTEM CONTROLS

A. General Requirements:
   1. Network: Indoor units and outdoor units shall include integral controls.
   3. Integration with Building Automation System: ASHRAE 135, BACnet IP and certified by BACnet Testing Lab (BTL), including the following:
      a. Ethernet connection via RJ-45 connectors and port with transmission at 100 Mbps or higher.
      b. Integration devices shall be connected to local uninterruptible power supply unit(s) to provide at least 5 minutes of battery backup operation after a power loss.
      c. Integration shall include control, monitoring, and scheduling change of value notifications.
   4. Operator Interface:
      a. Operators shall interface with system and unit controls through the following:
         1) Integration with Building Automation System.

B. VRF HVAC System Operator Software for PC:
1. Software offered by VRF HVAC system manufacturer shall provide system operators with ability to monitor and control VRF HVAC system(s) from a single dedicated Owner-furnished PC.
2. Software shall provide operator with a graphic user interface to allow monitoring and control of multiple central controllers from a single device location through point-and-click mouse exchange.
3. Plan views shall show building plans with location of indoor units and identification superimposed on plans.
4. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
5. Schedules operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Schedules daily, weekly, and annual events.
6. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
7. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
8. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
9. Displays service notifications and error codes.
10. Monitors and displays cumulative operating time of indoor units.
11. Able to disable and enable operation of individual controllers for indoor units.
12. Information displayed on individual controllers shall also be available for display.
13. Information displayed for outdoor units, including refrigerant high and low pressures.

C. Central Controllers:

1. Centralized control for all indoor and outdoor units from a single central controller location.
   a. Include multiple interconnected controllers as required.
2. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
3. Schedule operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
   a. Sets schedule for daily, weekly, and annual events.
   b. Schedule options available through central controller shall at least include the schedule options of controllers for indoor units.
4. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
5. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
6. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
7. Service diagnostics tool.
8. Able to disable and enable operation of individual controllers for indoor units.
9. Information displayed on individual controllers shall also be available for display through central controller.
10. Multiple RJ-45 ports for direct connection to a local PC and an Ethernet network switch.
11. Operator interface through a backlit, high-resolution color display touch panel and web accessible through standard web browser software.

D. Wired Controllers for Indoor Units:

1. Single controller capable of controlling multiple indoor units as group.
2. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.
3. On/Off: Turns indoor unit on or off.
4. Hold: Hold operation settings until hold is released.
8. Fan Speed Setting: Select between available options furnished with the unit.
9. Airflow Direction Setting: If applicable to unit, select between available options furnished with the unit.
10. Seven-day programmable operating schedule with up to eight events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.
11. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.
12. Occupancy detection.
13. Service Notification Display: "Filter".
15. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.
17. Setting stored in nonvolatile memory to ensure that settings are not lost if power is lost. Battery backup for date and time only.
18. Low-voltage power required for controller shall be powered through non-polar connections to indoor unit.

2.7 SYSTEM REFRIGERANT AND OIL

A. Refrigerant:

1. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.
2. ASHRAE 34, Class A1 refrigerant classification.

2.8 SYSTEM HYDRONIC PIPING

A. Comply with requirements in Section 232113 "Hydronic Piping" for system piping requirements.
2.9 SYSTEM REFRIGERANT PIPING

A. Comply with requirements in Section 232300 "Refrigerant Piping" for system piping requirements.

B. Refrigerant Piping:
   1. Copper Tube: ASTM B280, Type ACR.
   3. Brazing Filler Metals: AWS A5.8/A5.8M.

C. Refrigerant Tubing Kits:
   1. Furnished by VRF HVAC system manufacturer.
   2. Factory-rolled and -bundled, soft-copper tubing with tubing termination fittings at each end.
   3. Standard one-piece length for connecting to indoor units.
   4. Pre-insulated with flexible elastomeric insulation of thickness to comply with governing energy code and sufficient to eliminate condensation.
   5. Factory Charge: Dehydrated air or nitrogen.

D. Divided-Flow Specialty Fittings: Where required by VRF HVAC system manufacturer for proper system operation, VRF HVAC system manufacturer shall furnish specialty fittings with identification and instructions for proper installation by Installer.

E. Refrigerant Isolation Ball Valves:
   1. Description: Uni-body full port design, rated for maximum system temperature and pressure, and factory tested under pressure to ensure tight shutoff. Designed for valve operation without removing seal cap.
   2. Seals: Compatible with system refrigerant and oil. Seal service life of at least 20 years.
   3. Valve Connections: Flare or sweat depending on size.

2.10 PIPING AND TUBING INSULATION

A. Comply with Section 230700 – “HVAC Insulation:

2.11 SYSTEM CONTROL CABLE

A. Cable Rating: Listed and labeled for application according to NFPA 70.

   1. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
      a. Flame Travel Distance: 60 inches or less.
      b. Peak Optical Smoke Density: 0.5 or less.
      c. Average Optical Smoke Density: 0.15 or less.
2. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
3. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

B. Low-Voltage Control Cabling:

1. Paired Cable: NFPA 70, Type CMG.
   a. One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.
   b. PVC insulation.
   c. Braided or foil shielded.
   d. PVC jacket.
   e. Flame Resistance: Comply with UL 1685.

2. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   a. One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.
   b. PVC insulation.
   c. Braided or foil shielded.
   d. PVC jacket.
   e. NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.

C. TIA-485A Network Cabling:

1. Standard Cable: NFPA 70, Type CMG.
   a. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
   b. PVC insulation.
   c. Unshielded.
   d. PVC jacket.
   e. Flame Resistance: Comply with UL 1685.

2. Plenum-Rated Cable: NFPA 70, Type CMP.
   a. Paired, No. 22 AWG, stranded (7x30) tinned-copper conductors.
   b. Fluorinated ethylene propylene insulation.
   c. Unshielded.
   d. Fluorinated ethylene propylene jacket.
   e. NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.
D. Ethernet Network Cabling: TIA-568-C.2 Category 6 Insert category cable with RJ-45 connectors.

1. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of category cable indicated.
2. Conductors: 100-ohm, 23 AWG solid copper.
4. Cable Rating: By application.

E. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for control wiring and cable raceways.

2.12 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect factory-assembled equipment.
B. Equipment will be considered defective if it does not pass tests and inspections.
C. Prepare test and inspection reports for historical record. Submit reports only if requested.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.
C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.
D. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.
E. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.
F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION, GENERAL

A. Clearance:
   1. Maintain manufacturer's recommended clearances for service and maintenance.

B. Loose Components: Install components, devices, and accessories furnished by manufacturer, with equipment, that are not factory mounted.
   1. Loose components shall be installed by manufacturer's service representative or system Installer under supervision of manufacturer's service representative.
C. Equipment Restraint Installation: Install equipment with seismic-restraint device. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3.3 INSTALLATION OF INDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8 inch.

C. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.

D. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.

E. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.

F. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.

G. Provide lateral bracing if needed to limit movement of suspended units to not more than 0.25 inch.

3.4 INSTALLATION OF OUTDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Install outdoor units on support structures indicated on Drawings.

C. Pad-Mounted Installations: Install outdoor units on cast-in-place concrete equipment bases.

   1. Attachment: Install anchor bolts to elevations required for proper attachment to supported equipment.

   2. Grouting: Place grout under equipment supports and make bearing surface smooth.

D. Roof-Mounted Installations: Install outdoor units on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, stainless-steel fasteners.

3.5 GENERAL REQUIREMENTS FOR PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved on coordination drawings.
B. Install piping and tubing in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping and tubing at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping and tubing above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping and tubing to permit valve servicing.

F. Install piping and tubing at indicated slopes.

G. Install piping and tubing free of sags.

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

I. Install piping and tubing to allow application of insulation.

J. Install groups of pipes and tubing parallel to each other, spaced to permit applying insulation with service access between insulated piping and tubing.

K. Install sleeves for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

L. Install escutcheons for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.6 INSTALLATION OF SYSTEM CONDENSATE DRAIN PIPING

A. General Requirements for Drain Piping and Tubing:

1. Install a union in piping at each threaded unit connection.
2. Install an adjustable stainless-steel hose clamp with adjustable gear operator on unit hose connections. Tighten clamp to provide a leak-free installation.
3. If required for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping. Comply with more stringent of the following:
   a. Details indicated on Drawings.
   b. Manufacturer's requirements.
   c. Governing codes.
   d. In the absence of requirements, comply with requirements of ASHRAE handbooks.
4. Extend drain piping from units with drain connections to drain receptors as indicated on Drawings. If not indicated on Drawings, terminate drain connection at nearest accessible location that is not exposed to view by occupants.

5. Provide each 90-degree change in direction with a Y- or T-fitting. Install a threaded plug connection in the dormant side of fitting or future use as a service cleanout.

B. Gravity Drains:

1. Slope piping from unit connection toward drain termination at a constant slope of not less than two percent.

C. Pumped Drains:

1. If unit condensate pump or lift mechanism is not included with an integral check valve, install a full-size check valve in each branch pipe near unit connection to prevent backflow into unit.

3.7 INSTALLATION OF REFRIGERANT PIPING

A. Refrigerant Tubing Kits:

1. Unroll and straighten tubing to suit installation. Deviations in straightness of exposed tubing shall be unnoticeable to observer.
2. Support tubing using hangers and supports indicated at intervals not to exceed 5 feet. Minimum rod size, 1/4 inch.
3. Prepare tubing ends and make mating connections to provide a pressure tight and leak-free installation.

B. Install refrigerant piping according to ASHRAE 15 and governing codes.

C. Select system components with pressure rating equal to or greater than system operating pressure.

D. Install piping as short and direct as possible, with a minimum number of joints and fittings.

E. Arrange and install piping, valves and specialties in accessible locations to allow for service and inspection of equipment.

F. Install refrigerant piping and tubing in rigid or flexible conduit in locations where exposed to mechanical damage.

G. Unless otherwise required by VRF HVAC system manufacturer, slope refrigerant piping and tubing as follows:

1. Install horizontal hot-gas discharge piping and tubing with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps to entrain oil in vertical runs.
4. Liquid lines may be installed level.
H. When brazing, remove or protect components that could be damaged by heat.

I. Before installation, clean piping, tubing, and fittings to cleanliness level required by VRF HVAC system manufacturer.

J. Joint Construction (all refrigerant piping):
   1. Ream ends of tubes and remove burrs.
   2. Remove scale, slag, dirt, and debris from inside and outside of tube and fittings before assembly.
      a. Use Type BCuP (copper-phosphorus) alloy for joining copper fittings with copper tubing.
      b. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.

3.8 INSTALLATION OF PIPING AND TUBING 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. Installation to maintain a continuous vapor barrier.

B. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   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.

C. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are unavailable, 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. 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.

D. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. 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.

E. Where metal jackets are indicated, install with 2-inch 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 o.c. and at end joints.
3.9 INSTALLATION OF SYSTEM CONTROL CABLE

A. Comply with NECA 1.

B. Installation Method:

1. Install cables in raceways except as follows:
   a. Within equipment and associated control enclosures.
   b. In accessible ceiling spaces where open cable installation method may be used.
   c. In gypsum board partitions where cable may be enclosed within wall cavity.

2. Conceal raceway and cables except in unfinished spaces.

C. General Requirements for Cabling:

2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable.
5. Cables serving a common system may be grouped in a common raceway. Install control cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
11. Support: Do not allow cables to lie on removable ceiling tiles or access panels.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
15. Do not bend cables in a radius less than 10 times the cable OD.
16. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
17. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

D. Balanced Twisted-Pair Cable Installation:

2. Do not untwist balanced twisted-pair cables more than 1/2 inch at the point of termination to maintain cable geometry.

E. Open-Cable Installation:

1. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
2. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Separation from EMI Sources: Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded cable from potential EMI sources including electrical power wiring and equipment.

3.10 GROUNDING INSTALLATION

A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For low-voltage control cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.11 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.

1. Field service shall be performed by a factory-trained and -authorized service representative of VRF HVAC system manufacturer whose primary job responsibilities are to provide direct technical support of its products.
   
a. Additional factory-authorized representatives may assist with completion of certain activities only if supervised by manufacturer's employee. A factory-authorized representative shall not provide assistance without manufacturer's employee supervision.

2. Manufacturer shall provide on-site visits during the course of construction at installation milestones indicated. System Installer shall coordinate each visit in advance to give manufacturer sufficient notice to plan the visit.
   
a. First Visit: Kick-off meeting.
   b. Second Visit: At approximately 50 percent completion of system(s).
   c. Third Visit: At approximately 75 percent completion of system(s).
   d. Fourth Visit: Final inspection before system startup.

3. Kick-off Meeting:
a. Meeting shall include system Installer and other related trades with sole purpose of reviewing VRF HVAC system installation requirements and close coordination required to make a successful installation.

b. Meeting shall be held at Project site and scheduled at a mutually agreed to time that occurs before the start of any part of system installation.

c. Meeting shall cover the following as a minimum requirement:

1) Review of latest issue of Contract Documents, Drawings, and Specifications, relevant to VRF HVAC systems.
2) Manufacturer's installation requirements specific to systems being installed.
3) Review of all relevant VRF HVAC system submittals, including delegated-design submittals.
4) Required field activities related installation of VRF HVAC system.
5) Project team communication protocol, contact information, and exchange of responsibilities for each party involved, including manufacturer, supplier, system Installer, and other related trades.

4. Site Visits: Activities for each site visit shall include the following:

a. Meet with VRF HVAC system Installer to discuss field activities, issues, and suggested methods to result in a successful installation.

b. Offer technical support to Installer and related trades as related to VRF system(s) being installed.

c. Review progress of VRF HVAC system(s) installation for strict compliance with manufacturer's requirements.

d. Advise and if necessary assist Installer with updating related refrigerant calculations and system documentation.

e. Issue a report for each visit, documenting the visit.

1) Report to include name and contact information of individual making the visit.
2) Date(s) and time frames while on-site.
3) Names and contact information of people meeting with while on-site.
4) Clearly identify and list each separate issue that requires resolution. For each issue, provide a unique identification number, relevant importance, specific location or equipment identification, description of issue, recommended corrective action, and follow-up requirements needed. Include a digital photo for clarification if deemed to be beneficial.

5. Final Inspection before Startup:

a. Before inspection, Installer to provide written request to manufacturer stating the system is fully installed according manufacturer's requirements and ready for final inspection.

b. All system equipment and operating components shall be inspected. If components are inaccessible for inspection, they shall be made accessible before the final inspection can be completed.

c. Manufacturer shall provide a comprehensive inspection of all equipment and each operating component that comprise the complete system(s). Inspection shall follow a detailed checklist specific to each equipment and operating component.
d. Inspection reports for indoor units shall include, but not be limited to, the following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Controller type and model controlling unit.
13) Controller location.
14) Temperature settings and readings within an acceptable range.
15) Humidity settings and readings within an acceptable range.
16) Condensate removal acceptable.
17) Fan settings and readings within an acceptable range.
18) Unit airflow direction within an acceptable range.
19) If applicable, fan external static pressure setting.
20) Filter type and condition acceptable.
21) Noise level within an acceptable range.
22) Refrigerant piping properly connected and insulated.
23) Condensate drain piping properly connected and insulated.
24) If applicable, ductwork properly connected.
25) If applicable, external interlocks properly connected.
26) Remarks.

e. Inspection reports for outdoor units shall include, but not be limited to, the following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Condensate removal acceptable.
13) Noise level within an acceptable range.
14) Refrigerant piping properly connected and insulated.
15) Condensate drain piping properly connected and insulated.
16) Remarks.
f. Inspection reports for indoor units shall include, but not be limited to, the following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Controller type and model controlling unit.
13) Controller location.
14) Temperature settings and readings within an acceptable range.
15) Condensate removal acceptable.
16) Fan settings and readings within an acceptable range.
17) Fan external static pressure setting.
18) Filter type and condition acceptable.
19) Noise level within an acceptable range.
20) Refrigerant piping properly connected and insulated.
21) Condensate drain piping properly connected and insulated.
22) Automatic dampers properly installed and operating.
23) If applicable, external interlocks properly connected.
24) Remarks.

g. Installer shall provide manufacturer with the requested documentation and technical support during inspection.

h. Installer shall correct observed deficiencies found by the inspection.

i. Upon completing the on-site inspection, manufacturer shall provide a written report with complete documentation describing each inspection step, the result, and any corrective action required.

j. If corrective action is required by Installer that cannot be completed during the same visit, provide additional visits, as required, until deficiencies are resolved and systems are deemed ready for startup.

k. Final report shall indicate the system(s) inspected are installed according to manufacturer's requirements and are ready for startup.

B. Perform the following tests and inspections with the assistance of manufacturer's service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
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 motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Refrigerant Tubing Positive Pressure Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
2. After completion of tubing installation, pressurize tubing systems to a test pressure of not less than 1.25 times VRF HVAC system operating pressure, but not less than 600 psig, using dry nitrogen.
3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of 24 hours. Allowance for pressure changes attributed to changes in ambient temperature are acceptable.
4. Prepare test report to record the following information for each test:
   a. Name of person starting test, company name, phone number, and e-mail address.
   b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
   c. Detailed description of extent of tubing tested.
   d. Date and time at start of test.
   e. Test pressure at start of test.
   f. Outdoor temperature at start of test.
   g. Name of person ending test, company name, phone number, and e-mail address.
   h. Date and time at end of test.
   i. Test pressure at end of test.
   j. Outdoor temperature at end of test.
   k. Remarks:

5. Submit test reports for Project record.

D. Refrigerant Tubing Evacuation Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
2. After completion of tubing positive-pressure testing, evacuate tubing systems to a pressure of 500 microns.
3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of one hour with no change.
4. Prepare test report to record the following information for each test:
   a. Name of person starting test, company name, phone number, and e-mail address.
   b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
   c. Detailed description of extent of tubing tested.
   d. Date and time at start of test.
   e. Test pressure at start of test.
   f. Outdoor temperature at start of test.
   g. Name of person ending test, company name, phone number, and e-mail address.
   h. Date and time at end of test.
   i. Test pressure at end of test.
j. Outdoor temperature at end of test.
k. Remarks:

5. Submit test reports for Project record.
6. Upon successful completion of evacuation testing, system shall be charged with refrigerant.

E. System Refrigerant Charge:

1. Using information collected from the refrigerant tubing evacuation testing, system Installer shall consult variable refrigerant system manufacturer to determine the correct system refrigerant charge.
2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.
3. System refrigerant charging shall be witnessed by system manufacturer's representative.
4. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.

F. Products will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.12 STARTUP SERVICE

A. Engage a VRF HVAC system manufacturer's service representative to perform system(s) startup service.

1. Service representative shall be a factory-trained and -authorized service representative of VRF HVAC system manufacturer.
2. Complete startup service of each separate system.
3. Complete system startup service according to manufacturer's written instructions.

B. Startup checks shall include, but not be limited to, the following:

1. Check control communications of equipment and each operating component in system(s).
2. Check each indoor unit's response to demand for cooling and heating.
3. Check each indoor unit's response to changes in airflow settings.
4. Check each indoor unit and outdoor unit for proper condensate removal.
5. Check sound levels of each indoor and outdoor unit.

C. Installer shall accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.

1. Installer shall correct deficiencies found during startup service for reverification.

D. System Operation Report:
1. After completion of startup service, manufacturer shall issue a report for each separate system.
2. Report shall include complete documentation describing each startup check, the result, and any corrective action required.
3. Manufacturer shall electronically record not less than two hours of continuous operation of each system and submit with report for historical reference.
   a. All available system operating parameters shall be included in the information submitted.

3.13 ADJUSTING

A. Adjust equipment and components to function smoothly, and lubricate as recommended by manufacturer.
B. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.
C. Set field-adjustable switches and circuit-breaker trip ranges according to VRF HVAC system manufacturer's written instructions, and as indicated.
D. 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.

3.14 PROTECTION

A. Protect products from moisture and water damage. Remove and replace products that are wet, moisture damaged, or mold damaged.
B. Protect equipment from physical damage. Replace equipment with physical damage that cannot be repaired to new condition. Observable surface imperfections shall be grounds for removal and replacement.
C. Protect equipment from electrical damage. Replace equipment suffering electrical damage.
D. Cover and seal openings of equipment to keep inside of equipment clean. Do not remove covers until finish work is complete.

3.15 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
B. 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.
Completion. Upgrading software shall include operating system and new or revised licenses for using software.

3.16 DEMONSTRATION

A. Engage a VRF HVAC system manufacturer's employed training instructor or factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain entire system.

B. Schedule and Duration:
   1. Schedule training with Owner at least 10 business days before first training session.
   2. Training shall occur before Owner occupancy.
   3. Training shall be held at mutually agreed date and time during normal business hours.

C. Training Format: Individual training modules shall include classroom training followed by hands-on field demonstration and training.

D. Training Materials: Provide training materials in electronic format to each attendee.
   1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.

E. Acceptance: Obtain Owner written acceptance that training is complete and requirements indicated have been satisfied.

END OF SECTION 238129
SECTION 238216 - REFRIGERANT AIR COILS

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 refrigerant air coils.

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 each air coil.
   2. Include rated capacities, operating characteristics, and pressure drops for each air coil.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which coil location and ceiling-mounted access panels are shown and coordinated with each other.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 DESCRIPTION
A. ASHRAE Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
2.2 REFRIGERANT AIR COILS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Trane
2. Aerofin.
3. Carrier Corporation; a unit of United Technologies Corp.
4. Trane.

B. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.

C. Minimum Working-Pressure Rating: 300 psig.

D. Source Quality Control: Factory tested to 450 psig.

E. Tubes: ASTM B 743 copper, minimum 0.020 inch thick.

1. Provide vertical distributor.

F. Fins: Aluminum, minimum 0.006 inch thick.

G. Suction and Distributor Piping: ASTM B 88, Type L copper tube with brazed joints.

H. Frames: Galvanized-steel channel frame, minimum 0.052 inch thick for flanged mounting.

I. Frames: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch thick for flanged mounting.

J. Capacities and Characteristics: See Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

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

3.2 INSTALLATION

A. Install coils level and plumb.
B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Install stainless-steel drain pan under each cooling coil.
   1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1.
   2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
   3. Extend drain pan upstream and downstream from coil face.
   4. Extend drain pan under coil headers and exposed supply piping.

D. Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.

E. Straighten bent fins on air coils.

F. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to coils to allow service and maintenance.

C. Connect refrigerant piping according to Section 232300 "Refrigerant Piping."

END OF SECTION 238216
SECTION 238223 - UNIT VENTILATORS

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 unit ventilators and accessories with the following heating and cooling features:
   1. Hydronic heating coil.
   2. Direct-expansion (DX) refrigerant cooling coil.
   3. For DX coil control see Section 238129 – Variable-Refrigerant-Flow HVAC Systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product
   1. Include rated capacities, operating characteristics, and furnished specialties and accessories for each unit type and configuration.

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. Detail anchorages and attachments to structure and to supported equipment.
   4. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For unit ventilators to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.
1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Unit Ventilator Filters: Furnish 1 spare filter(s) for each filter installed.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.7 COORDINATION

A. Coordinate layout and installation of unit ventilators and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate size and location of unit with existing wall sleeves and outdoor-air intake louvers.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Direct expansion coil leak.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Factory-packaged and -tested units rated according to AHRI 840, ASHRAE 33, and UL 1995.
2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Trane
2. Carrier Corporation; a unit of United Technologies Corp.
3. Nesbitt Aire, Inc.
4. Daikin.

2.3 CABINETS

A. Insulation: Minimum 1/2-inch-thick, coated glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. Coil Section Insulation: Insulate coil section according to Section 230616 "HVAC Equipment Insulation."

1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Main and Auxiliary Drain Pans: Insulated galvanized steel with plastic liner, formed as required by ASHRAE 62.1. Drain pans shall be removable.

D. Cabinet Frame and Access Panels: Welded-steel frame with removable panels fastened with hex-head tamperproof fasteners and key-operated control and valve access doors.

1. Steel components exposed to moisture shall be powder-coat finished.

E. Cabinet Finish: Powder coat, in manufacturer's standard color as selected by Architect.

F. Indoor-Supply-Air Grille: Aluminum, adjustable linear bar.

G. Return-Air Inlet: Front toe space, unless otherwise indicated.

H. End Panels: Matching material and finish of unit ventilator.
2.4 COILS
   A. Test and rate unit ventilator coils according to ASHRAE 33.
   B. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
   C. Indoor Refrigerant Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and brazed joints at fittings. Comply with AHRI 210/240, and leak test to minimum 450 psig for a minimum 300-psig working pressure. Include thermal expansion valve.

2.5 INDOOR FAN
   A. Fan and Motor Board: Removable.
      1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
      2. Fan Shaft and Bearings: Hollow-steel shaft with permanently lubricated, resiliently mounted bearings.
      4. Wiring Termination: Connect motor to chassis wiring with plug connection.

2.6 DAMPERS
   A. Mixing Dampers: Galvanized-steel blades with edge and end seals and nylon bearings; with electric actuator.
   B. Outdoor-Air Dampers: Galvanized-steel blades with edge and end seals and nylon bearings; with electric actuator.
   C. Face and Bypass Dampers: Galvanized-steel damper blades with edge and end seals and nylon bearings; with factory-mounted electric actuator.
   D. Comply with ASHRAE/IES 90.1.

2.7 ACCESSORIES
   A. Subbase: Sheet metal floor-mounting base with leveling screws and black enamel finish.
   B. Insulated false back with gasket seals on wall and outdoor-air plenum.
      1. Insulation: Minimum 1/2-inch- thick, coated glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
a. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.

b. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Return-air plenum, 6 inches thick, designed to take return air from top inlet grilles in cabinets on both sides of unit ventilator with gasket seals on wall and outdoor-air plenum extension.

D. Duct flanges for supply-, return-, and outdoor-air connections.

E. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.

1. Glass Fiber Treated with Adhesive: 80 percent arrestance and MERV 5.

2.8 FACTORY HYDRONIC PIPING PACKAGE

A. Piping: ASTM B 88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet. Crossover piping, NPS 1-1/2 with shutoff valves.

B. Control Valves: Electric actuators compatible with terminal controller and building controls.

1. Two-way, modulating control valve for hot-water coil.

C. Isolation Valves, Strainers, Unions, and Balance Valves:

1. Two-Piece Ball Valves: Bronze body with stainless-steel ball and stem and galvanized-steel lever handle for each supply and return connection. If balancing device is combination shutoff type with memory stop, isolation valve may be omitted on the return.

2. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig working pressure, 250 deg F maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and a memory stop to retain set position.

2.9 LINEAR EXPANSION VALVE (LEV) PACKAGE

A. Provide a linear expansion valve and control box interface to connect the unit ventilator to the variable refrigerant flow system and corresponding outdoor condensing unit.

1. The LEV package shall control room temperature by setting the valve opening to a standard opening set for each operation frequency of its associated compressor.

2. The LEV valve shall provide defrost control.

3. The LEV package shall meet design capacity of its associated unit ventilator.

4. Provide suction line and liquid line thermistor.

5. Provide supply air and return air thermistor.
2.10 BASIC UNIT CONTROLS

A. Control devices and operational sequences are specified on drawings and in Section 238129 – Variable-Refrigerant-Flow HVAC Systems.

B. Building Automation System (BAS) Interface Requirements:
   1. Interface relay for scheduled operation.
   2. Interface relay to provide indication of fault at the central workstation.
   3. Provide BACnet interface for central BAS workstation for the following functions:
      a. Adjust set points.
      b. Unit ventilator start, stop, and operating status.
      c. Data inquiry to include outdoor-air damper position, supply- and room-air temperature.
      d. Occupied and unoccupied schedules.

C. Electrical Connection: Factory wire motors and controls for a single electrical connection.

2.11 METAL PIPING COMPARTMENTS AND FILLER PIECES

A. Include manufacturer's standard cabinets to match unit ventilators with required installation hardware as indicated:
   1. Utility compartment with access panel with key-operated lock.
   2. Wall and corner filler sections, and end panels finished to match shelving.

B. Painted Finish: Manufacturer's standard baked enamel, in color selected by Architect, applied before shipping.

C. Coordinate compartment size to house Linear Expansion Valve (LEV) Package.

2.12 CAPACITIES AND CHARACTERISTICS – See Schedules


PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, to receive unit ventilators for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electrical connections to verify actual locations before unit ventilator installation.

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

A. Install unit ventilators to comply with NFPA 90A.

B. Suspend horizontal unit ventilators from structure with threaded steel rods and minimum 1.0-inch static-deflection spring hangers. Vibration isolators are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

C. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above finished floor, unless otherwise noted.

D. Set remote controller type to refrigerant system (Mitsubishi) controller and coil selected for ventilation application.

E. Integrate fan control.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

   1. Install piping adjacent to machine to allow service and maintenance.
   2. Connect piping to unit ventilator factory hydronic piping package. Install piping package if shipped loose.
   3. Connect condensate drain to indirect waste as indicated.

B. Install refrigerant piping as required by Section 232300 "Refrigerant Piping," and add refrigerant as required to compensate for length of piping.

   1. Provide brazed connection to LEV valve and control connections and power to LEV control box.
   2. Follow manufacturer’s written installation instruction including maximum distances between valve and control box.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain unit ventilators.

END OF SECTION 238223
SECTION 238236 - FINNED-TUBE RADIATION HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes electric, baseboard radiation heaters.

1.3 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. Indicate location and size of each field connection.
   3. Indicate location and arrangement of integral controls.
   4. Include diagrams for power, signal, and control wiring.

C. Color Samples for Verification: For each type of exposed finish.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Method of attaching finned-tube radiation heaters to building structure.

B. Field quality-control reports.
PART 2 - PRODUCTS

2.1 ELECTRIC BASEBOARD RADIATION HEATERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Chromalox, Inc.
3. Vulcan.

B. Description: Factory-packaged units constructed according to UL 499, UL 1030, and UL 2021.

1. 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. Heating Elements: Nickel-chromium-wire heating element enclosed in metallic sheath mechanically bonded to fins, with high-temperature cutout and sensor running the full length of the element. Element supports shall eliminate thermal expansion noise.

1. Volts: See Drawing Schedule.
2. Phase: See Drawing Schedule.
3. Hertz: See Drawing Schedule.


1. Full-height back.
2. End panel.
3. Enclosure Height: See Drawing Schedule.
4. Enclosure Depth: See Drawing Schedule.
5. Finish: Baked-enamel finish in manufacturer's standard color as selected by Architect.
6. Element Brackets: Primed and painted steel to support front panel and element.

E. Unit Controls:

1. Remote line-voltage thermostat.
2. Control section with disconnect switch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive finned-tube radiation heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in for electrical connections to verify actual locations before installation of finned-tube radiation heaters.

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

3.2 BASEBOARD RADIATION HEATER INSTALLATION

A. Install units level and plumb.

B. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

C. Install valves within reach of access door provided in enclosure.

3.3 CONNECTIONS

A. Ground electric finned-tube radiation heaters according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 238236
SECTION 238239 - CABINET UNIT HEATERS

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 cabinet unit heaters with centrifugal fans and electric-resistance heating coils.

1.3 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, 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.

1.4 INFORMATIONAL SUBMITTALS
A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Cabinet Unit-Heater Filters: Furnish one spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Carrier Corporation; a unit of United Technologies Corp.
2. Chromalox, Inc.
3. INDEECO.
5. QMark; Marley Engineered Products.

2.2 DESCRIPTION

A. Factory-assembled and -tested unit complying with AHRI 440.

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 UL 2021.

2.3 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.4 CABINETS

A. Material: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.
   1. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch-thick galvanized sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
   2. Recessed Flanges: Steel, finished to match cabinet.
   3. Control Access Door: Key operated.

2.5 FILTERS

A. Minimum Arrestance: And a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. Washable Foam: 70 percent arrestance and MERV 3.
2. Glass Fiber Treated with Adhesive: 80 percent arrestance and MERV 5.
3. Pleated: 90 percent arrestance and MERV 7.

2.6 COILS

A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and
hum, mounted in ceramic inserts in galvanized-steel housing; with fuses in terminal box for
overcurrent protection and limit controls for high-temperature protection. Terminate elements in
stainless-steel machine-staked terminals secured with stainless-steel hardware.

2.7 CONTROLS

A. Fan and Motor Board: Removable.

1. Fan: Forward curved, double width, centrifugal, directly connected to motor;
thermoplastic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel
fan scrolls.
2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply
with requirements in Section 230513 "Common Motor Requirements for HVAC
Equipment."
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

B. Basic Unit Controls:

1. Control voltage transformer.
2. Wall-mounted thermostat with the following features:
   b. Fan on-auto switch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation
tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater
installation.

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

A. Suspend cabinet unit heaters from structure with elastomeric hangers. Vibration isolators are specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls.

C. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 238239
SECTION 238240 - PROPELLER UNIT HEATERS

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 propeller unit heaters with electric-resistance heating coils.

1.3 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 location and size of each field connection.
   4. Include details of anchorages and attachments to structure and to supported equipment.
   5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
   6. Indicate location and arrangement of integral controls.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Airtherm; a Mestek company.
3. Trane Inc.
4. Vulcan
5. Modine

2.2 DESCRIPTION

A. Assembly including casing, coil, fan, and motor in vertical or horizontal discharge configuration, as scheduled, with adjustable discharge louvers.

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 UL 2021.

D. Comply with UL 823.

2.3 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.4 HOUSINGS

A. Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.
2.5 COILS

A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.

2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

2.6 FAN AND MOTOR

A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

B. Motor: Permanently lubricated, multispeed. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.7 CONTROLS

A. Control Devices:

1. Wall-mounted thermostat.

2.8 CAPACITIES AND CHARACTERISTICS: See Drawing Schedules.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

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

3.2 INSTALLATION

A. Install propeller unit heaters to comply with NFPA 90A.

B. Install propeller unit heaters level and plumb.
C. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls.

3.3 CONNECTIONS

A. Comply with safety requirements in UL 1995.

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

3.5 ADJUSTING

A. Adjust initial temperature set points.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain propeller unit heaters.

END OF SECTION 238240
SECTION 260513 - MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section includes cables and related cable splices, terminations, and accessories for medium-voltage (2001 to 35,000 V) electrical distribution systems.

1.3 DEFINITIONS
   A. Jacket: A continuous nonmetallic outer covering for conductors or cables.
   C. Sheath: A continuous metallic covering for conductors or cables.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of cable. Include splices and terminations for cables and cable accessories.

1.5 INFORMATIONAL SUBMITTALS

1.6 QUALITY ASSURANCE
   A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.
   B. Testing Agency Qualifications: Member company of NETA or an NRTL.
      1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 FIELD CONDITIONS
   A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Construction Manager no fewer than five days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2 and NFPA 70.

C. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

2.2 CABLES

A. Manufacturers: Subject to compliance with requirements, undefined:
   1. General Cable; General Cable Corporation.
   2. Kerite Co. (The).
   3. Okonite Company (The).
   4. Rome Cable Corporation.
   5. Southwire Company.

B. Cable Type: Type MV 105.

C. Conductor Insulation: Ethylene-propylene rubber.
   1. Voltage Rating: 15 kV.
   2. Insulation Thickness: 133 percent insulation level.

D. Conductor: Copper.

E. Comply with UL 1072, AEIC CS8.

F. Conductor Stranding: Concentric lay, Class B.

G. <Double click to insert sustainable design text for lead content.>

H. Three-Conductor Cable Assembly: Three insulated, shielded conductors cabled together.
   1. Circuit Identification: Color-coded tape (black, red, blue) under the metallic shielding.
2.3 CONNECTORS

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

1. 3M.
3. Engineered Products Company.
4. Raychem; a brand of nVent.
5. Thomas & Betts Corporation; A Member of the ABB Group.

B. Comply with ANSI C119.4 for connectors between aluminum conductors or for connections between aluminum to copper conductors.

C. Copper-Conductor Connectors: Copper barrel crimped connectors.

2.4 SOLID TERMINATIONS

A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. 3M.
3. Engineered Products Company.
4. Raychem; a brand of nVent.
5. Thomas & Betts Corporation; A Member of the ABB Group.

B. Multiconductor Cable Sheath Seals: Type recommended by seal manufacturer for type of cable and installation conditions, including orientation.

1. Compound-filled, cast-metal-body, metal-clad cable terminator for metal-clad cable with external plastic jacket.
2. Heat-shrink sheath seal kit with phase- and ground-conductor rejacketing tubes, cable-end sealing boot, and sealing plugs for unused ground-wire openings in boot.

2.5 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. 3M.
3. Engineered Products Company.
4. Raychem; a brand of nVent.
5. Thomas & Betts Corporation; A Member of the ABB Group.
C. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

2.6 SPLICE KITS

A. Description: For connecting medium voltage cables; type as recommended by cable or splicing kit manufacturer for the application.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. 3M.
   3. Engineered Products Company.
   4. Raychem; a brand of nVent.
   5. Thomas & Betts Corporation; A Member of the ABB Group.

C. Standard: Comply with IEEE 404.

D. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, materials, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.
   2. Premolded, EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.

2.7 MEDIUM-VOLTAGE TAPES

A. Description: Electrical grade, insulating tape rated for medium voltage application.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. 3M.
   3. Engineered Products Company.
   4. Raychem; a brand of nVent.
   5. Thomas & Betts Corporation; A Member of the ABB Group.

2.8 ARC-PROOFING MATERIALS

A. Description: Fire retardant, providing arc flash protection.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. **3M.**
2. **Cooper Power Systems, an Eaton business.**
3. **Engineered Products Company.**
4. **Raychem; a brand of nVent.**
5. **Thomas & Betts Corporation; A Member of the ABB Group.**

C. **Arc-Proofing Tape:** Fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, and compatible with cable jacket.

### 2.9 FAULT INDICATORS

A. **Indicators:** Automatically reset fault indicator with inrush restraint feature, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.

B. **Resetting Tool:** Designed for use with fault indicators, with moisture-resistant storage and carrying case.

### 2.10 SOURCE QUALITY CONTROL

A. **Test and inspect cables according to ICEA S-97-682 before shipping.**

B. **Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig.**

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

A. **Install cables according to IEEE 576.**

B. **Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inches on the pull rope.**

1. **Wire Brush Mandrel:** Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.

2. **Rubber Duct Swab:** Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.

C. **Pull Conductors:** Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.

2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.

3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.

4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.

D. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.

E. Install cable splices at pull points and elsewhere as indicated; use standard kits.

F. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.

G. Install separable insulated-connector components as follows:

   1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
   2. Portable Feed-Through Accessory: At each terminal junction, with one on each terminal.
   3. Standoff Insulator: At each terminal junction, with one on each terminal.

H. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:

   1. Clean cable sheath.
   2. Wrap metallic cable components with 10-mil pipe-wrapping tape.
   3. Smooth surface contours with electrical insulation putty.
   4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
   5. Band arc-proofing tape with two layers of 1-inch wide half-lapped, adhesive, glass-cloth tape at each end of the arc-proof tape.

I. Install fault indicators on each phase where indicated.

J. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

K. Identify cables according to Section 260553 "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

3.2 FIELD QUALITY CONTROL

A. Testing Agency: 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 stated in NETA ATS. Certify compliance with test parameters.

2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.

3. Perform direct-current High Potential test of each new conductor according to NETA ATS, Ch. 7.3.3. Do not exceed cable manufacturer's recommended maximum test voltage.

4. Perform Partial Discharge test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.

5. Perform Dissipation Factor test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.

C. Medium-voltage cables will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 260513
SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Copper building wire rated 600 V or less.
2. Fire-alarm wire and cable.
3. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

1. Section 260513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35,000 V.
2. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.
3. Section 271313 "Communications Copper Backbone Cabling" for twisted pair cabling used for data circuits.
4. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair cabling used for data circuits.

1.3 DEFINITIONS

A. RoHS: Restriction of Hazardous Substances.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For.

B. Field quality-control reports.
PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Belden Inc.
2. Cerro Wire LLC.
3. General Cable Technologies Corporation.
4. Okonite Company (The).
5. Southwire Company.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. 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 B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

E. Conductor Insulation:

1. Type NM: Comply with UL 83 and UL 719.
2. Type RHH and Type RHW-2: Comply with UL 44.
3. Type USE-2 and Type SE: Comply with UL 854.
4. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
5. Type THHN and Type THWN-2: Comply with UL 83.
6. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
7. Type UF: Comply with UL 83 and UL 493.
8. Type XHHW-2: Comply with UL 44.
9. .

F. Shield:

1. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.
2.2 FIRE-ALARM WIRE AND CABLE

A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Allied Wire & Cable Inc.
2. West Penn Wire.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 16 AWG.

   1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

   1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
   2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
   3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

2.3 CONNECTORS AND SPLICES

A. **Description:** Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

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

1. 3M Electrical Products.
2. Gardner Bender.
4. ILSCO.
5. O-Z/Gedney; a brand of Emerson Industrial Automation.
6. Thomas & Betts Corporation; A Member of the ABB Group.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

   1. Material: Copper.
   2. Type: Two hole with standard barrels.
3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

D. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

E. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.


G. PV Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN/THWN-2, single conductors in raceway Type XHHW-2, single conductors in raceway.

B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.

D. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.

E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway Metal-clad cable, Type MC, limited to 10’ in length.

F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
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 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 INSTALLATION OF FIRE-ALARM WIRING

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal pathway according to Section 270528.29 "Hangers and Supports for Communications Systems."

1. Install plenum cable in environmental airspaces, including plenum ceilings.
2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system shall be installed in a dedicated pathway system. This system shall not be used for any other wire or cable.

C. Wiring Method:

1. 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.
2. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is not permitted.
3. Signaling Line Circuits: Power-limited fire-alarm cables shall not be installed in the same cable or pathway as signaling line circuits.

D. 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.
E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.

F. 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.

G. 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.

H. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 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 inches of slack.

D. Comply with requirements in Section 283111 "Digital, Addressable Fire-Alarm System" 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."

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
   2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors feeding the following critical equipment and services for compliance with requirements:
      a. 
   3. Perform each of the following visual and electrical tests:
      a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
      b. Test bolted connections for high resistance using one of the following:
         1) A low-resistance ohmmeter.
         2) Calibrated torque wrench.
         3) Thermographic survey.
      c. Inspect compression-applied connectors for correct cable match and indentation.
      d. Inspect for correct identification.
      e. Inspect cable jacket and condition.
      f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
      g. Continuity test on each conductor and cable.
      h. Uniform resistance of parallel conductors.
   4. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
      a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
      b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
   5. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

B. Cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports to record the following:
1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519
SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section includes grounding and bonding systems and equipment, plus the following special
      applications:

      1. Foundation steel electrodes.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

1.5 CLOSEOUT SUBMITTALS

1.6 QUALITY ASSURANCE

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by
      a qualified testing agency, and marked for intended location and application.

   B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS
   A. Manufacturers: Subject to compliance with requirements, available manufacturers offering
      products that may be incorporated into the Work include, but are not limited to, the following:

      1. Burndy; Part of Hubbell Electrical Systems.
2. ERICO; a brand of nVent.
3. ILSCO.
4. O-Z/Gedney; a brand of Emerson Industrial Automation.
6. Thomas & Betts Corporation; A Member of the ABB Group.

2.3 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
   3. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   4. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

C. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

D. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

E. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

F. Conduit Hubs: Mechanical type, terminal with threaded hub.

G. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

I. Lay-in Lug Connector: Mechanical type, aluminum terminal with set screw.
J. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.

K. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.

L. Straps: Solid copper, cast-bronze clamp. Rated for 600 A.

M. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal one-piece clamp.

N. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

O. Water Pipe Clamps:
   1. Mechanical type, two pieces with zinc-plated bolts.
      b. Listed for direct burial.
   2. U-bolt type with malleable-iron clamp and copper ground connector.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.
   1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches long.
   2. Backfill Material: Electrode manufacturer's recommended material.

C. Ground Plates: 1/4 inch thick, hot-dip galvanized.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
   1. Bury at least 30 inches below grade.
   2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

C. Grounding Conductors: Green-colored insulation with continuous yellow stripe.

D. Isolated Grounding Conductors: Green-colored insulation with more than one continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to
normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

E. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

F. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

3.5 EQUIPMENT GROUNDING

A. 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.

B. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

C. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway
fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

3.6 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. Use exothermic welds for all below-grade connections.
3. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

G. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
   a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
   b. Perform tests by fall-of-potential method according to IEEE 81.
4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.
E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).
7. ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526
SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Steel slotted support systems.
   2. Aluminum slotted support systems.
   3. Conduit and cable support devices.
   4. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
   5. Fabricated metal equipment support assemblies.

B. Related Requirements:
   1. Section 260548.16 "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

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. Slotted support systems, hardware, and accessories.
      b. Clamps.
      c. Hangers.
      d. Sockets.
      e. Eye nuts.
      f. Fasteners.
      g. Anchors.
      h. Saddles.
      i. Brackets.
      j. .
   2. Include rated capacities and furnished specialties and accessories.
1.4 INFORMATIONAL SUBMITTALS

1.5 QUALITY ASSURANCE

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Tube & Conduit; a part of Atkore International.
   b. B-line, an Eaton business.
   c. CADDY; a brand of nVent.
   d. G-Strut.
   e. Thomas & Betts Corporation; A Member of the ABB Group.
   f. Unistrut; Part of Atkore International.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
4. Channel Width: Selected for applicable load criteria.
5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cooper Industries, Inc.
   b. Thomas & Betts Corporation; A Member of the ABB Group.
   c. Unistrut; Part of Atkore International.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
5. Channel Width: Selected for applicable load criteria.
6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) B-line, an Eaton business.
      2) Hilti, Inc.

2. 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.

3. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.

4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F 3125/F 3125M, Grade A325.


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 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA 101
3. NECA 102.

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

C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT IMC and RMC may be supported by openings through structure members, according to 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 shall be weight of supported components plus 200 lb .

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To New Concrete: Bolt to concrete inserts.
2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
3. To Existing Concrete: Expansion anchor fasteners.
4. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
6. 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.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use [3000 psi] <Insert value>, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base as follows:
   1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Comply with requirements in Section 099123 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

END OF SECTION 260529
SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Metal conduits and fittings.
   2. Nonmetallic conduits and fittings.
   3. Metal wireways and auxiliary gutters.
   5. Handholes and boxes for exterior underground cabling.
B. Related Requirements:
   1. Section 078413 "Penetration Firestopping" for firestopping at conduit and box entrances.
   2. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
   3. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

1.3 DEFINITIONS
A. ARC: Aluminum rigid conduit.
B. GRC: Galvanized rigid steel conduit.
C. IMC: Intermediate metal conduit.
1.4 ACTION SUBMITTALS

1.5 INFORMATIONAL SUBMITTALS

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Tube & Conduit; a part of Atkore International.
   b. FSR Inc.
   c. O-Z/Gedney; a brand of Emerson Industrial Automation.
   d. Republic Conduit.
   e. Southwire Company.
   f. Thomas & Betts Corporation; A Member of the ABB Group.
   g. Wheatland Tube Company.

2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3. GRC: Comply with ANSI C80.1 and UL 6.

4. IMC: Comply with ANSI C80.6 and UL 1242.

5. PVC-Coated Steel Conduit: PVC-coated.
   a. Comply with NEMA RN 1.
   b. Coating Thickness: 0.040 inch, minimum.

6. EMT: Comply with ANSI C80.3 and UL 797.

7. FMC: Comply with UL 1; zinc-coated steel or aluminum.

8. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Tube & Conduit; a part of Atkore International.
   b. FSR Inc.
   c. O-Z/Gedney; a brand of Emerson Industrial Automation.
   d. Republic Conduit.
   e. Southwire Company.
   f. Thomas & Betts Corporation; A Member of the ABB Group.
   g. Wheatland Tube Company.

2. Comply with NEMA FB 1 and UL 514B.

3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

4. Fittings, General: Listed and labeled for type of conduit, location, and use.
5. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.

6. Fittings for EMT:
   a. Material: Steel.
   b. Type: Setscrew or compression.

7. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

8. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. RACO; Hubbell.
   b. Thomas & Betts Corporation; A Member of the ABB Group.

2. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3. Fiberglass:
   b. Comply with UL 2515 for aboveground raceways.
   c. Comply with UL 2420 for belowground raceways.

4. ENT: Comply with NEMA TC 13 and UL 1653.

5. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

6. LFNC: Comply with UL 1660.

B. Nonmetallic Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. RACO; Hubbell.
   b. Thomas & Betts Corporation; A Member of the ABB Group.

2. Fittings, General: Listed and labeled for type of conduit, location, and use.

3. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
   a. Fittings for LFNC: Comply with UL 514B.
4. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

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

1. B-line, an Eaton business.
2. Hoffman; a brand of nVent.
3. MonoSystems, Inc.
4. Square D.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 BOXES, ENCLOSURES, AND CABINETS

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

2. EGS/Appleton Electric.
3. FSR Inc.
4. Hoffman; a brand of nVent.
5. Hubbell Incorporated.
6. Hubbell Incorporated; Wiring Device-Kellems.
7. Milbank Manufacturing Co.
8. MonoSystems, Inc.
10. Oldcastle Enclosure Solutions.
11. RACO; Hubbell.
12. Spring City Electrical Manufacturing Company.
14. Thomas & Betts Corporation; A Member of the ABB Group.
15. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

J. Gangable boxes are allowed.

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.

2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Oldcastle Enclosure Solutions.
   b. Oldcastle Precast, Inc.
2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC."
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes **12 Inches Wide by 24 Inches Long** and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

**PART 3 - EXECUTION**

3.1 **RACEWAY APPLICATION**

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC.
2. Underground Conduit: RNC, Type EPC-80-PVC.
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.
   d. Gymnasiums.
3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
5. Damp or Wet Locations: IMC.
6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: **3/4-inch** trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

G. Install surface raceways only where indicated on Drawings.

H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.

D. Do not fasten conduits onto the bottom side of a metal deck roof.

E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

F. Complete raceway installation before starting conductor installation.

G. Arrange stub-ups so curved portions of bends are not visible above finished slab.

H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated.

K. Install conduits parallel or perpendicular to building lines.

L. Support conduit within 12 inches of enclosures to which attached.

M. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.

2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

3. Arrange raceways to keep a minimum of 1 inch of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to RNC, Type EPC-40-PVC, before rising above floor.

N. Stub-Ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

O. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

P. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

Q. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

R. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

S. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

T. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

U. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

V. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

W. Surface Raceways:
1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

X. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
Y. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all 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 raceway enters a building or structure.
3. Conduit extending from interior to exterior of building.
4. Conduit extending into pressurized duct 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.

Z. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

AA. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
   c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
   d. Attics: 135 deg F temperature change.
   e. .
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

BB. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 36 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

CC. 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.
DD. 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.

EE. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

FF. Locate boxes so that cover or plate will not span different building finishes.

GG. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

HH. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

II. Set metal floor boxes level and flush with finished floor surface.

JJ. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes with bottom below frost line, 36" below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 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."
3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

A. 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
SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

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. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
      2. Sleeve-seal systems.
      5. Silicone sealants.
   B. Related Requirements:
      1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

PART 2 - PRODUCTS

2.1 SLEEVES
   A. Wall Sleeves:
      2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
   B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
   C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
      b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
      a. Advance Products & Systems, Inc.
      b. CALPICO, Inc.
      c. Metraflex Company (The).
      d. Pipeline Seal and Insulator, Inc.
      e. Proco Products, Inc.
   2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Carbon steel.
   4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
   1. **Manufacturers:** Subject to compliance with requirements, provide products by the following:
      a. **HOLDRITE.**
2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.


C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

   a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."

   b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
   2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544
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. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels.
4. Tapes and stencils.
5. Tags.

1.3 ACTION SUBMITTALS

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1.

B. Comply with NFPA 70.


D. Comply with ANSI Z535.4 for safety signs and labels.

E. Comply with NFPA 70E and Section 260573.19 "Arc-Flash Hazard Analysis" requirements for arc-flash warning labels.

F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
2.2 COlOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:
   1. Black letters on an orange field.
   2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.

   1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
   2. Colors for 208/120-V Circuits:
      a. Phase A: Black.
      b. Phase B: Red.
      c. Phase C: Blue.
   3. Colors for 240-V Circuits:
      a. Phase A: Black.
      b. Phase B: Red.
   4. Colors for 480/277-V Circuits:
      b. Phase B: Orange.
      c. Phase C: Yellow.
   7. Colors for Isolated Grounds: Green with two or more yellow stripes.

C. Raceways and Cables Carrying Circuits at More Than 600 V:

   1. Black letters on an orange field.
   2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

D. Warning Label Colors:

   1. Identify system voltage with black letters on an orange background.
   2. 

E. Warning labels and signs shall include, but are not limited to, the following legends:

   1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
   2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
   3. 

F. Equipment Identification Labels:

   1. Black letters on a white field.
2.3 LABELS

A. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

1. **Manufacturers**: Subject to compliance with requirements, undefined:
   
   a. **Brady Corporation**.
   
   b. **HellermannTyton**.
   
   c. **Marking Services, Inc.**.
   
   d. **Panduit Corp**.
   
   e. **Seton Identification Products**.

B. Self-Adhesive Wraparound Labels: Preprinted Write-on, 3-mil- thick, flexible label with acrylic pressure-sensitive adhesive.

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

   a. **A'n D Cable Products**.
   
   b. **Brady Corporation**.
   
   c. **Brother International Corporation**.
   
   d. **emeco**.
   
   e. **Grafoplast Wire Markers**.
   
   f. **Ideal Industries, Inc.**
   
   g. **LEM Products Inc.**
   
   h. **Marking Services, Inc.**
   
   i. **Panduit Corp**.
   
   j. **Seton Identification Products**.

2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.

3. Marker for Labels: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.4 BANDS AND TUBES

A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.

1. **Manufacturers**: Subject to compliance with requirements, undefined:

   a. **Brady Corporation**.
   
   b. **HellermannTyton**.
   
   c. **Marking Services, Inc.**
   
   d. **Panduit Corp**.

IDENTIFICATION FOR ELECTRICAL SYSTEMS 260553 - 3
2.5 TAPES AND STENCILS

A. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.

1. **Manufacturers:** Subject to compliance with requirements, undefined:
   a. Brady Corporation.
   b. Carlton Industries, LP.
   c. emedco.
   d. Marking Services, Inc.

B. Tape and Stencil: 4-inch- wide black stripes on 10-inch centers placed diagonally over orange background and are 12 inches wide. Stop stripes at legends.

1. **Manufacturers:** Subject to compliance with requirements, undefined:
   a. HellermannTyton.
   b. LEM Products Inc.
   c. Marking Services, Inc.
   d. Seton Identification Products.

C. Floor Marking Tape: 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

1. **Manufacturers:** Subject to compliance with requirements, undefined:
   a. Carlton Industries, LP.
   b. Seton Identification Products.

D. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.6 TAGS

A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
   a. Brady Corporation.
   b. Carlton Industries, LP.
   c. emedco.
   d. Marking Services, Inc.
   e. Seton Identification Products.

B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015 inch thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

   a. [Brady Corporation.](#)
   b. [Carlton Industries, LP.](#)
   c. [emedco.](#)
   d. [Grafoplast Wire Markers.](#)
   e. [LEM Products Inc.](#)
   f. [Marking Services, Inc.](#)
   g. [Panduit Corp.](#)
   h. [Seton Identification Products.](#)

2.7 **SIGNS**

A. Laminated Acrylic or Melamine Plastic Signs:

1. **Manufacturers:** Subject to compliance with requirements, undefined:

   a. [Brady Corporation.](#)
   b. [Carlton Industries, LP.](#)
   c. [emedco.](#)
   d. [Marking Services, Inc.](#)

2. Engraved legend.

3. **Thickness:**

   a. For signs up to 20 sq. in., minimum 1/16 inch thick.
   b. For signs larger than 20 sq. in., 1/8 inch thick.
   c. Engraved legend with black letters on white face.
   d. Self-adhesive.
   e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 **MISCELLANEOUS IDENTIFICATION PRODUCTS**

**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 each 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 600 V: Identification shall completely
encircle cable or conduit. Place identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

H. System Identification for Raceways and Cables over 600 V: Identification shall completely
encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by
side.

1. Secure tight to surface of conductor, cable, or raceway.

I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control,
and signal connections.

J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red
background with minimum 3/8-inch- high letters for emergency instructions at equipment used
for power transfer.

K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for
viewing from the floor.

L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the
following systems with the wiring system legend and system voltage. System legends shall be
as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."

M. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.

N. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and
accessibility.

O. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and
accessibility.
P. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
   1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

Q. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

R. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.

S. Metal Tags:
   1. Place in a location with high visibility and accessibility.
   2. Secure using general-purpose cable ties.

T. Nonmetallic Preprinted Tags:
   1. Place in a location with high visibility and accessibility.
   2. Secure using general-purpose cable ties.

U. Laminated Acrylic or Melamine Plastic Signs:
   1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
   2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high sign; where two lines of text are required, use labels 2 inches high.

### 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.

   1. Locate identification at changes in direction, at penetrations of walls and floors, and at 10-foot maximum intervals.

D. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Snap-around labels Snap-around color-coding bands for raceway and cables.
1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

E. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 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-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

F. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive wraparound labels snap-around labels snap-around color-coding bands self-adhesive vinyl tape to identify the phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.

H. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use with the conductor or cable designation, origin, and destination.

I. Control-Circuit Conductor Termination Identification: For identification at terminations, provide with the conductor designation.

J. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

K. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

L. Workspace Indication: Apply floor marking tape or tape and stencil to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting:.

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.


O. Equipment Identification Labels:
1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
2. Outdoor Equipment: Stenciled legend 4 inches high.
3. Equipment to Be Labeled:
   a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, engraved, laminated acrylic or melamine label.
   b. Enclosures and electrical cabinets.
   c. Switchgear.
   d. Switchboards.
   e. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
   f. .

END OF SECTION 260553
SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Photoelectric switches.
2. Indoor occupancy and vacancy sensors.
4. High-bay occupancy sensors.

B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of lighting control software.
b. Faulty operation of lighting control devices.

c. 

2. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES, SOLID STATE, FLEXIBLE MOUNTING

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

1. Cooper Industries, Inc.
2. Leviton Manufacturing Co., Inc.
3. NSi Industries LLC.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES, SOLID STATE, LUMINAIRE-MOUNTED

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Solid state, with SPST dry contacts rated for 1800 VA inductive, to operate connected load, complying with UL 773, and compatible with CFL and LED lamps.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
3. Time Delay: Thirty-second minimum, to prevent false operation.
5. Mounting: Twist lock complying with ANSI C136.10, with base from same source and manufacturer as switch.
6. Failure Mode: Luminaire stays ON.

2.3 OUTDOOR PHOTOELECTRIC SWITCHES, LOW VOLTAGE

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.4 INDOOR OCCUPANCY AND VACANCY SENSORS

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

1. Cooper Industries, Inc.
2. Hubbell Building Automation, Inc.
3. Leviton Manufacturing Co., Inc.
4. Lithonia Lighting; Acuity Brands Lighting, Inc.
5. Lutron Electronics Co., Inc.
6. **NSi Industries LLC.**
7. **Philips Lighting Controls.**
8. **Sensor Switch, Inc.**
9. **WattStopper, a Legrand® Group brand.**

**B. General Requirements for Sensors:**

2. Dual technology.
3. Separate power pack.
4. Hardwired connection to switch; and BAS and lighting control system.
5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. **Operation:**
   a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
7. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A.
9. Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
10. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
12. Bypass Switch: Override the "on" function in case of sensor failure.
13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.

**C. Dual-Technology Type:** Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. **Sensitivity Adjustment:** Separate for each sensing technology.
2. **Detector Sensitivity:** Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

2.5 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Industries, Inc.
2. Hubbell Building Automation, Inc.
3. Leviton Manufacturing Co., Inc.
4. Lithonia Lighting; Acuity Brands Lighting, Inc.
5. Lutron Electronics Co., Inc.
6. NSi Industries LLC.
7. Philips Lighting Controls.
8. Sensor Switch, Inc.

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox, with provisions for connection to BAS using hardwired connection.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
4. Switch Rating: Not less than 800-VA LED load at 120 V, 1200-VA LED load at 277 V, and 800-W incandescent.

C. Wall-Switch Sensor Tag WS1:
1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft.
2. Sensing Technology: Dual technology - PIR and ultrasonic.
3. Switch Type: SP, manual "on," automatic "off."
5. Voltage: Match the circuit voltage.
6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
10. Faceplate: Color matched to switch.
D. Wall-Switch Sensor Tag WS2:

1. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft.
2. Sensing Technology: PIR.
3. Switch Type: SP, manual "on," automatic "off."
5. Voltage: Match the circuit voltage.
6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
7. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
10. Faceplate: Color matched to switch.

2.6 HIGH-BAY OCCUPANCY SENSORS

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

1. Hubbell Building Automation, Inc.

B. Description: Solid-state unit. The unit is designed to operate with the lamp and ballasts indicated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.
3. Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.
5. Operating Ambient Conditions: 32 to 149 deg F.
7. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
8. Detector Technology: PIR.
9. Power and dimming control from the luminaire ballast that has been modified to include the dimming capacitor.

C. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet.

D. Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.
2.7 EXTREME-TEMPERATURE OCCUPANCY SENSORS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Ceiling-mounted, solid-state, extreme-temperature occupancy sensors with a separate power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended application in damp locations.
2. Operation: Turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
3. Operating Ambient Conditions: From minus 40 to plus 125 deg F.
4. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
5. Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
6. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind cover.
7. Bypass Switch: Override the "on" function in case of sensor failure.
8. Automatic Light-Level Sensor: Adjustable from 2 to 10 fc; keep lighting off when selected lighting level is present.

C. Detector Technology: PIR. Ceiling mounted; detect occupants in coverage area by their heat and movement.

1. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in..
2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1500 sq. ft. when mounted on a 96-inch- high ceiling.

2.8 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

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

3.2 SENSOR INSTALLATION

A. Comply with NECA 1.

B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

C. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 CONTACTOR INSTALLATION

A. Comply with NECA 1.

B. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.

C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
3.5 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
   1. Identify controlled circuits in lighting contactors.
   2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

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 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. 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 shall include operating system and new or revised licenses for using software.
   1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

END OF SECTION 260923
SECTION 261329 - MEDIUM-VOLTAGE, PAD-MOUNTED SWITCHGEAR

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 dead-front, remotely controlled insulated vacuum load and fault interrupting switchgear.

1.3 DEFINITIONS

A. BIL: Basic Impulse Insulation Level.

B. Bushing: An insulating structure including a central conductor, or providing a central passage for a conductor, with provision for mounting on a barrier, conducting or otherwise, for insulating the conductor from the barrier and conducting current from one side of the barrier to the other.

C. Bushing Elbow: An insulated device used to connect insulated conductors to separable insulated connectors on dead-front, pad-mounted switchgear and to provide a fully insulated connection. Also called an "elbow connector."

D. Bushing Insert: That component of a separable insulated connector that is inserted into a bushing well to complete a dead-front, load break or non-load break, separable insulated connector (bushing).

E. Bushing Well: A component of a separable insulated connector, either permanently welded or clamped to an enclosure wall or barrier, having a cavity that receives a replaceable component (bushing insert) to complete the separable insulated connector (bushing).

F. Fault Interrupter: A self-controlled mechanical switching device capable of making, carrying, and automatically interrupting an alternating current. It includes an assembly of control elements to detect overcurrents and control the fault interrupter. A fault interrupter always consists of a switching device, a control unit, and sensors for current and/or voltage sensing.

G. Hotstick: An insulated stick, usually made of fiberglass, that is used to work energized overhead conductors and operate electrical equipment that is overhead, underground, and compartmentalized.


I. SCADA: Supervisory control and data acquisition.
J. Way: A three-phase or single-phase circuit connection to the bus that may contain combinations of switches and protective devices or may be a solid bus.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
   2. Time-current characteristic curves for overcurrent protective devices.

B. Shop Drawings: For pad-mounted switchgear.
   1. Include a tabulation of installed devices with features and ratings.
   2. Include dimensioned plans and elevations, showing dimensions, shipping sections, and weights of each assembled section. Elevations shall show major components and features, and they will mimic bus diagram.
   3. Include a plan view and cross section of equipment base showing clearances, manufacturer's recommended work space, and locations of penetrations for grounding and conduits. Show location of anchor bolts and leveling channels.
   4. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, and location and size of each field connection.
   5. Include list of materials.
   6. Locate accessory and spare equipment storage.
   7. Include single-line diagram.
   8. Include control power wiring diagrams.
   9. Include battery, charger, and transfer switch ratings.
  10. Include copy of nameplate.
  11. Switchgear Ratings:
      a. Voltage.
      b. Continuous current.
      c. Short-circuit rating.
      d. BIL.
  15. Wiring Diagrams: For each switchgear assembly, include the following:
      a. Power, signal, and control wiring.
      b. Three-line diagrams of current and future secondary circuits, showing device terminal numbers and internal diagrams.
      c. Schematic control diagrams.
      d. Diagrams showing connections of component devices and equipment.
      e. Schematic diagrams showing connections to remote devices.
1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For pad-mounted switchgear.
   1. Switch ratings as listed in IEEE C37.74.
   2. Interrupter ratings as listed in IEEE C37.60.
   3. Coating system compliance with the IEEE standard listed in "Enclosure" Article.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchgear and switchgear components to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
      b. Time-current curves, including selectable ranges for each type of overcurrent protective device.
      c. Record as-left set points of adjustable devices.

1.7 QUALITY ASSURANCE

1.8 WARRANTY

A. Special Battery Warranties: Manufacturer and Installer agree to repair or replace the switchgear control system storage batteries that fail in materials or workmanship within specified warranty period.
   1. Warranted Cycle Life for VRLA Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F:
         1) Discharge Rate: 8 hours.
         2) Discharge Duration: 8 hours.
         3) Discharge End Voltage: 1.67 V.
         1) Discharge Rate: 30 minutes.
         2) Discharge Duration: 30 minutes.
         3) Discharge End Voltage: 1.67 V.
         1) Discharge Rate: 15 minutes.
         2) Discharge Duration: 45 seconds.
         3) Discharge End Voltage: 1.67 V.
2. Warranted Cycle Life for Premium VRLA Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F:

   1) Discharge Rate: 8 hours.
   2) Discharge Duration: 8 hours.
   3) Discharge End Voltage: 1.67 V.

   1) Discharge Rate: 30 minutes.
   2) Discharge Duration: 30 minutes.
   3) Discharge End Voltage: 1.67 V.

   1) Discharge Rate: 15 minutes.
   2) Discharge Duration: 1.5 minutes.
   3) Discharge End Voltage: 1.67 V.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, undefined:
   1. ABB.
   2. Cooper Industries.

2.2 SYSTEM DESCRIPTION

A. Manufactured Unit: Pad-mounted switchgear, designed for application in solidly grounded neutral underground distribution systems.

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 IEEE C2.

D. Comply with IEEE C37.74.

2.3 PERFORMANCE REQUIREMENTS

A. Service Conditions:
   1. Switchgear shall be suitable for operation under service conditions specified as usual service conditions in IEEE C37.20.3.
   2. .
2.4 RATINGs

A. Switchgear is applied to a nominal 13.2 kV (L-L) medium-voltage electrical power system. Minimum ratings of the switchgear shall be as follows:

1. Rated Maximum Voltage and Rated BIL: 15.5 kV and 95 kV BIL.
2. Continuous and Load Interrupting Current: 600 A.
3. Short-Time and Short-Circuit Interrupting Current: 12.5 kA rms Sym.

2.5 SWITCHGEAR ENCLOSURE

A. Weatherproof enclosure with an integral skid mounting frame, designed for mounting on a concrete pad, suitable to allow skidding or rolling of the switchgear in any direction, and with provision for anchoring the frame to the pad.

B. Enclosure Integrity: Comply with IEEE C57.12.28 for compartmentalized enclosures that contain energized electrical equipment in excess of 600 V that may be exposed to the public.

1. Each vertical section shall have the following features:
   a. Structural design and anchorage adequate to resist loads imposed by 125-mph wind.
   b. Space heater operating at one-half or less of rated voltage, sized to prevent condensation, controlled by thermostats to maintain temperature of each section above expected dew point.
   c. Louvers equipped with insect and rodent screens and filters, and arranged to permit air circulation while excluding rodents and exterior dust.
   d. Weatherproof ground-fault circuit interrupter duplex receptacles.
   e. Power for heaters and receptacles shall be provided by control power transformer.
   f. Skid Mounted: Mount each shipping group on an integral base frame as a complete weatherproof unit.

C. Corrosion Protection: Enclosure coating system shall be factory applied, meeting the requirements of IEEE C57.12.28, in manufacturer's standard color.

2.6 SWITCHGEAR CONSTRUCTION

A. Dead-front, front and rear access switchgear.

B. Each disconnect switch in switched ways shall be in a sealed, dielectric filledsteel tank, factory-filled with mineral oil.

1. Mineral Oil: Comply with ASTM D 3487, Type II, and tested for compliance with ASTM D 117. Provide enclosure with level gauge to monitor the dielectric level; automatic pressure relief valve; and fill, drain, and sampling valves.

C. Construct switchgear assembly with switched ways that have front-accessible terminations for cables entering from below and with manual operating provisions with a lineman's hotstick.
D. Trapped Key Interlocks: Kirk key interlock system using a dowel pin design having no openings. Brass housing and 316 stainless-steel key and lock bolts.

E. Viewing Windows: For each switch, located adjacent to manual operating devices, and positioned to show switch contact position.

F. Grounding: Provision to make grounding cable and wire connections at each way.

2.7 SWITCHED WAYS

A. Source Switch Ways: Non-fused, hotstick operated, ganged vacuum load interrupter switches, in series with a visible-break disconnect switch.

1. Rated Continuous Current and Load Switching Current: 600 A.
2. Vacuum Load Interrupter:
   a. With 24 V dc motor operators to open or close the load interrupter.
   b. Trip-free switch mechanism. Closing the switch shall be independent of the speed of the operating handle.
3. Visible-Break Disconnect Switch: Two positions, with open and closed positions. The switch shall be mechanically interlocked so that the vacuum interrupter opens and closes first.
   a. Switch position indicator, clearly labeled.
   b. Padlocking and tagging provisions.


1. Rated Continuous Current and Load Switching Current: 600 A.
2. Vacuum Fault Interrupter:
   a. Operated by a motor-charged stored energy mechanism, with provision to manually charge the mechanism. Charging motors shall operate at 24 V ac.
   b. Auxiliary Switches: Provide two auxiliary switches, each with field-selectable NC or NO switch position, for connection of remote indication of the position of the switched way. The switches shall be rated at 15 A, 120 V ac, and 1 A, 120 V dc.
   c. Trip-free switch mechanism when manually operated. Closing the switch shall be independent of the speed of the operating handle.
   d. Single operating handle and a clearly labeled switch position indicator; open, closed, tripped.
   e. Operations Counters: Mechanical type, linked to the operating handle of each switched way.
   f. Padlocking and tagging provisions.
3. Visible-Break Disconnect Switch: Two positions, with open and closed positions. The switch shall be mechanically interlocked so that the switch cannot be operated unless the vacuum fault interrupter is open.
a. Switch position indicator, clearly labeled.
b. Padlocking and tagging provisions.

C. Controls:

2. Switch Status LEDs: "Open" and "closed" lights. Show status of disconnect switch using its auxiliary contact.
3. Motor Actuator Process LEDs: "Opening" and "closing" lights indicating that the selected motor is operating the switch.
4. Power Switch: "On" and "off" toggle switch and circuit protector, to disconnect the dc supply to its motor and provide overload and short-circuit protection.
5. 120 V ac LED to display battery system power level.
6. Battery voltage meter to show battery condition.
7. Local and Remote Selector: In the "local" position remote operation of the switches is disabled and is possible only under the control of switchgear-mounted push buttons.

D. Overcurrent and Control Relays: Field-adjustable microprocessor electronic relays in each phase at indicated locations. Provide for current adjustment from 0 to 600 A.

1. Device Functions: 51/50, 51N/50N, or 51G/50G according to IEEE C37.2.
2. Device Functions: .

2.8 AUTOMATIC SOURCE TRANSFER CONTROLS

A. An automatic switch control system shall execute manual, automatic source-transfer, and SCADA operation of the source and fault interrupting switch ways. The source-transfer controls shall open an incoming switch way where voltage is lost and close the other incoming switch way if voltage is present. The controls shall include an overcurrent lockout that prevents the closing of a switch way into a system fault.

B. The automatic switch control system shall execute remote commands received from a SCADA master station and transmit switchgear operation information to a SCADA master station using DNP3 communications protocol. Execution of remote commands shall include enabling of the source-transfer controls and transfer of switch ways to "close," "open," and "ground" positions. Transmission of switchgear information shall include switch way positions and DC supply system status. Additional switchgear information that shall be transmitted follows:

1. Voltage.
3. .

C. The control shall have communication port provisions for connection to a multi-mode serial fiber link.

2.9 BUSHINGS

A. Separable insulated connectors shall be used to connect primary cable. Comply with requirements in Section 260513 "Medium-Voltage Cables."
1. Bushings: One-piece, 600 A, BIL ratings the same as the connectors. Comply with IEEE 386.
2. Supply a standoff bracket or parking stand for each bushing, mounted horizontally adjacent to each bushing.

2.10 SURGE ARRESTERS
A. Distribution class; metal-oxide-varistor type, fully shielded, separable elbow type, suitable for plugging into the inserts. Comply with IEEE C62.11 and IEEE 386.
2. Maximum Continuous Operating Voltage: 15 kV rms.

2.11 WARNING LABELS AND SIGNS
A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for labels and signs.
1. High-Voltage Warning Label: Self-adhesive labels on the outside of the high-voltage compartment door(s). Legend shall be "DANGER HIGH VOLTAGE" printed in two lines of minimum 2-inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background.
2. Arc-Flash Warning Label: Self-adhesive labels on the outside of the high-voltage compartment door(s), warning of potential electrical arc-flash hazards and appropriate personal protective equipment required.

2.12 SOURCE QUALITY CONTROL
A. Factory Tests: Comply with requirements in IEEE C37.60 and IEEE C37.74 for testing procedures.
1. Circuit Resistance Test: Verify that switchgear contacts have been properly aligned and current transfer points have been properly assembled.
2. Power-frequency dry withstand voltage test.
3. Dielectric withstand test; one-minute dry power-frequency.
4. Calibrate overcurrent devices for conformance to published time-current characteristic curves.
5. Sealed Tank Leak Test:
   b. The test procedure for vacuum switchgear shall be as follows:
      1) Each vacuum tube shall be identified by its serial number. Its vacuum pressure level shall be tested by the manufacturer of the vacuum interrupter. Document the test results.
      2) After assembly of the switchgear way, test the vacuum pressure level of the vacuum tubes by the routine dielectric test across the open contacts. The test
voltage shall be stated by the manufacturer. The dielectric test shall be carried out after the mechanical routine test.

6. Operating tests shall verify the following:
   
a. Switch position indicators and contacts are in the correct position for both the open and closed positions.
b. Insulating medium quantity indicator (if provided) is functioning properly.
c. Circuit configuration is shown correctly.
d. Mechanical interlocks are in place and operative.
e. Position and polarity of current transformers meets requirements.
f. Control, secondary wiring, and accessory devices are connected correctly.
g. Devices and relays actually operate as intended. Circuits for which operation is not feasible shall be checked for continuity.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Upon delivery of switchgear and prior to unloading, inspect equipment for damage.
   
1. Examine tie rods and chains to verify they are undamaged and tight and that blocking and bracing are tight.
2. Verify that there is no evidence of load shifting in transit and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
3. Examine switchgear for external damage, including dents or scratches in doors and sill, and termination provisions.
4. Compare switchgear and accessories received with the bill of materials to verify that the shipment is complete. Verify that switchgear and accessories conform to the manufacturer's quotation and Shop Drawings. If the shipment is not complete or does not comply with project requirements, notify the manufacturer in writing immediately.
5. Unload switchgear, observing packing label warnings and handling instructions.
6. Open compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Handling:
   
1. Handle switchgear, according to manufacturer's recommendations; avoid damage to the enclosure, termination compartments, base, frame, and internal components. Do not subject switchgear to impact, jolting, jarring, or rough handling.
2. Transport switchgear upright to avoid internal stresses on equipment mounting assemblies. Do not tilt or tip switchgear.
3. Use spreaders or a lifting beam to obtain a vertical lift and to protect switchgear from straps bearing against the enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
4. Do not damage structure when handling switchgear.

C. Storage:
1. Switchgear may be stored outdoors. If possible, store switchgear at final installation locations on concrete pads. If dry concrete surfaces are not available, use pallets of adequate strength to protect switchgear from direct contact with the ground. Ensure switchgear is level.
2. Protect switchgear from physical damage. Do not store switchgear in the presence of corrosive or explosive gases.
3. Store switchgear with compartment doors closed.

D. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders have to cross section barriers to reach load or line lugs.

E. Pre-Installation Checks:


F. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at switchgear location.

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

3.2 SWITCHGEAR INSTALLATION

A. Comply with NECA 1.

B. Equipment Mounting:

1. Comply with requirements for vibration isolation and seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Install level and plumb, tilting less than 1.5 degrees when energized.

D. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

E. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and IEEE C2.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

1. For counterpoise, use tinned bare copper cable not smaller than No. 4/0 AWG, buried not less than 30 inches below grade interconnecting the grounding electrodes. Bond surge arrester and neutrals directly to the switchgear enclosure and then to the grounding
electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable with no kinks or sharp bends.

2. Fence and equipment connections shall not be smaller than No. 4 AWG. Ground fence at each gate post and corner post and at intervals not exceeding 10 ft. Bond each gate section to the fence post using 1/8 by 1 inch tinned flexible braided copper strap and clamps.

3. Make joints in grounding conductors and loops by exothermic weld or compression connector.

4. Terminate all grounding and bonding conductors on a common equipment grounding terminal on the switchgear enclosure.

5. Complete the switchgear grounding and surge protector connections prior to making any other electrical connections.

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer recommendations.

2. Bundle associated phase, neutral, and equipment grounding conductors together within the switchgear enclosure. Arrange conductors such that there is not excessive strain on the connections that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.

C. Terminate medium-voltage cables in incoming section of switchgear according to Section 260513 "Medium-Voltage Cables."

3.4 SIGNS AND LABELS

A. Comply with the installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

B. Install warning signs as required to comply with OSHA 29 CFR 1910.269.

3.5 SYSTEM FUNCTION TESTS

A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after "Field Quality Control" tests have been completed and all components have passed specified tests.

1. Develop test parameters and perform tests for evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.

2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.

3. Verify the correct operation of sensing devices, alarms, and indicating devices.
3.6 FOLLOW-UP SERVICE

A. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove all necessary covers prior to the inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of the switchgear.
2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C.
3. Record of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used, and lists the results as follows:
   a. Description of equipment to be tested.
   b. Discrepancies.
   c. Temperature difference between the area of concern and the reference area.
   d. Probable cause of temperature difference.
   e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
   f. Identify load conditions at time of inspection.
   g. Provide photographs and thermograms of the deficient area.
4. Act on inspection results according to the recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems.
SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Service and distribution switchboards rated 600 V and less.
   2. Surge protection devices.
   3. Disconnecting and overcurrent protective devices.
   4. Accessory components and features.
   5. Identification.

B. Related Requirements
   1. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash analysis and arc-flash label requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.
   1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

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 NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
   6. Detail utility company's metering provisions with indication of approval by utility company.
   7. Include evidence of NRTL listing for series rating of installed devices.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
10. Include schematic and wiring diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

   a. Routine maintenance requirements for switchboards and all installed components.
   b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.
2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.
1.7 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Accredited by NETA.
   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and to prevent condensation.

C. Handle and prepare switchboards for installation according to NECA 400.

1.9 FIELD CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:
   1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding 104 deg F.
      b. Altitude: Not exceeding 6600 feet.

C. Unusual Service Conditions: NEMA PB 2, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet.

D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electric service.
   2. Indicate method of providing temporary electric service.
   3. Do not proceed with interruption of electric service without Construction Manager's written permission.
4. Comply with NFPA 70E.

1.10 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.

   1. Warranty Period: Three years from date of Substantial Completion.

B. Manufacturer's Warranty: Manufacturer's agrees to repair or replace surge protection devices that fail in materials or workmanship within specified warranty period.

   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 SWITCHBOARDS

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

   1. Eaton.
   2. General Electric Company.
   4. Square D; by Schneider Electric.

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 2.

F. Comply with NFPA 70.

G. Comply with UL 891.

H. Front-Connected, Front-Accessible Switchboards:
   1. Main Devices: Panel mounted.
   3. Sections front and rear aligned.

I. Indoor Enclosures: Steel, NEMA 250, Type 1.

J. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

K. Barriers: Between adjacent switchboard sections.

L. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

M. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
   1. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.

N. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

O. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

P. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks.

Q. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

R. Removable, Hinged Rear Doors and Compartment Covers: Secured by captive thumb screws, for access to rear interior of switchboard.
S. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

T. Pull Box on Top of Switchboard:
   1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
   2. Set back from front to clear circuit-breaker removal mechanism.
   3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
   4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
   5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

U. Buses and Connections: Three phase, four wire unless otherwise indicated.
   1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
   3. Copper feeder circuit-breaker line connections.
   4. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
   5. Ground Bus: 1/4-by-2-inch hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
   6. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
   7. Disconnect Links:
      a. Isolate neutral bus from incoming neutral conductors.
      b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
   8. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

2.3 SURGE PROTECTION DEVICES

   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Eaton.
      2. General Electric Company.
      4. Square D; by Schneider Electric.

   B. SPDs: Comply with UL 1449, Type 1.
C. Features and Accessories:
   1. Integral disconnect switch.
   2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
   3. Indicator light display for protection status.
   4. Surge counter.

D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
   1. Line to Neutral: 700 V for 208Y/120 V.
   2. Line to Ground: 1200 V for 208Y/120 V.
   3. Line to Line: 1000 V for 208Y/120 V.

F. SCCR: Equal or exceed 100 kA.

G. Nominal Rating: 20 kA.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with series-connected rating interrupting capacity to meet available fault currents.
   1. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
   2. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
   3. MCCB Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.
      b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
      c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
      d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
B. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems" or manufacturer's instructions.

2.6 IDENTIFICATION

A. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.

B. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

C. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NECA 400.

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.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after switchboard is anchored in place.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to switchboards.

6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.

C. 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."

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.

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. 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 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 indicated.

3.6 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.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 262413
SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. ATS: Acceptance testing specification.
B. GFCI: Ground-fault circuit interrupter.
C. GFEP: Ground-fault equipment protection.
D. HID: High-intensity discharge.
E. MCCB: Molded-case circuit breaker.
F. SPD: Surge protective device.
G. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of panelboard.

1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

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 NRTL listing for series rating of installed devices.
7. Include evidence of NRTL listing for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.5 INFORMATIONAL SUBMITTALS

1.6 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.8 QUALITY ASSURANCE
A. Manufacturer Qualifications: ISO 9001 or ISO 9002 certified.
1.9  DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407.

1.10  FIELD CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature: Not exceeding minus 22 deg F to plus 104 deg F.
   b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

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

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Construction Manager's written permission.
3. Comply with NFPA 70E.

1.11  WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.

1. SPD Warranty Period: Five years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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 PB 1.

D. Comply with NFPA 70.

E. Enclosures: Surface-mounted, dead-front cabinets.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
      b. Kitchen Areas: NEMA 250, Type 4X.
      c. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250,
   2. Height: 84 inches maximum.
   3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
   4. Finishes:
      a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   5. .

F. Incoming Mains:
   1. Location: Convertible between top and bottom.
   2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

G. Phase, Neutral, and Ground Buses:
      a. Plating shall run entire length of bus.
      b. Bus shall be fully rated the entire length.
   2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
   3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. **Full-Sized Neutral**: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

**H. Conductor Connectors**: Suitable for use with conductor material and sizes.

1. **Material**: Hard-drawn copper, 98 percent conductivity.
2. **Terminations**: Shall allow use of 75 deg C rated conductors without derating.
3. **Size**: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. **Main and Neutral Lugs**: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
5. **Ground Lugs and Bus-Configured Terminators**: Type, with a lug on the bar for each pole in the panelboard.
6. **Feed-Through Lugs**: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
7. **Subfeed (Double) Lugs**: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
8. **Gutter-Tap Lugs**: Type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.

**I. NRTL Label**: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

**J. Future Devices**: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. **Percentage of Future Space Capacity**: 20 percent.

**K. Panelboard Short-Circuit Current Rating**: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

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2.2 **PERFORMANCE REQUIREMENTS**

**A. Surge Suppression**: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.
2.3  POWER PANELBOARDS

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

1. Eaton.
4. Square D; by Schneider Electric.

B. Panelboards: NEMA PB 1, distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

   1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: Circuit breaker.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

F. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

   1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

2.4  LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

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

1. Eaton.
4. Square D; by Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

   1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
G. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

H. Column-Type Panelboards: Single row of overcurrent devices with narrow gutter extension and overhead junction box equipped with ground and neutral terminal buses.

1. Doors: Concealed hinges secured with multipoint latch with tumbler lock; keyed alike.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

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

1. Eaton.
4. Square D; by Schneider Electric.

B. MCCB: Comply with UL 489, with series-connected rating interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:
   a. Inverse time-current element for low-level overloads.
   b. Instantaneous magnetic trip element for short circuits.
   c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
4. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
6. MCCB Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Breaker handle indicates tripped status.
   c. UL listed for reverse connection without restrictive line or load ratings.
   d. Lugs: style, suitable for number, size, trip ratings, and conductor materials.
   e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
   f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   g. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
2.6 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

   1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
   1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards according to NECA 407.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 INSTALLATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Comply with NECA 1.

C. Install panelboards and accessories according to NECA 407.

D. Equipment Mounting:
   1. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
   2. Attach panelboard to the vertical finished or structural surface behind the panelboard.

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Mount top of trim 90 inches above finished floor unless otherwise indicated.

G. Mount panelboard cabinet plumb and rigid without distortion of box.

H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

I. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.

J. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.
   2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

K. 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.

L. Install filler plates in unused spaces.

M. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

N. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
O. Mount spare fuse cabinet in accessible location.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:

   1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Perform optional tests. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:

      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.

c. Instruments and Equipment:
   1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.
   1. Measure loads during period of normal facility operations.
   2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
   3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
   4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416
SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Standard-grade receptacles, 125 V, 20 A.
2. GFCI receptacles, 125 V, 20 A.
3. Twist-locking receptacles.
4. Toggle switches, 120/277 V, 20 A.
5. Occupancy sensors.

1.3 DEFINITIONS

A. AFCI: Arc-fault circuit interrupter.
B. BAS: Building automation system.
C. EMI: Electromagnetic interference.
D. GFCI: Ground-fault circuit interrupter.
E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
F. RFI: Radio-frequency interference.
G. SPD: Surge protective device.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
1.5 INFORMATIONAL SUBMITTALS

1.6 CLOSEOUT SUBMITTALS

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Service/Power Poles; but no fewer than.
2. Floor Service-Outlet Assemblies; but no fewer than.
3. Poke-Through, Fire-Rated Closure Plugs: floor service outlets installed, but no fewer than.
4. SPD Receptacles: of each type installed, but no fewer than.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Comply with NFPA 70.

C. RoHS compliant.

D. Comply with NEMA WD 1.

E. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with requirements in this Section.

F. Devices for Owner-Furnished Equipment:

1. Receptacles: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

G. Device Color:

1. Wiring Devices Connected to Normal Power System: White unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Essential Electrical System: Red.
3. SPD Devices: Blue.
4. Isolated-Ground Receptacles: As specified above, with orange triangle on face.

H. Wall Plate Color: For plastic covers, match device color.
I. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

A. Duplex Receptacles, 125 V, 20 A:
   1. **Manufacturers:** Subject to compliance with requirements, provide products by the following:
      a. **Hubbell Incorporated; Wiring Device-Kellems.**
      b. **Leviton Manufacturing Co., Inc.**
      c. **Pass & Seymour/Legrand (Pass & Seymour).**
   2. Description: Two pole, three wire, and self-grounding.
   3. Configuration: NEMA WD 6, Configuration 5-20R.
   4. Standards: Comply with UL 498 and FS W-C-596.

B. Weather-Resistant Duplex Receptacle, 125 V, 20 A:
   1. **Manufacturers:** Subject to compliance with requirements, provide products by the following:
      a. **Hubbell Incorporated; Wiring Device-Kellems.**
      b. **Leviton Manufacturing Co., Inc.**
      c. **Pass & Seymour/Legrand (Pass & Seymour).**
   2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
   3. Configuration: NEMA WD 6, Configuration 5-20R.
   5. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

2.3 GFCI RECEPTACLES, 125 V, 20 A

A. Duplex GFCI Receptacles, 125 V, 20 A:
   1. **Manufacturers:** Subject to compliance with requirements, provide products by the following:
      a. **Hubbell Incorporated; Wiring Device-Kellems.**
      b. **Leviton Manufacturing Co., Inc.**
      c. **Pass & Seymour/Legrand (Pass & Seymour).**
   2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
   3. Configuration: NEMA WD 6, Configuration 5-20R.
   4. Type: Feed through.
   5. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.
2.4 *TWIST-LOCKING RECEPTACLES*

A. Twist-Lock, Single Receptacles, 250 V, 20 A:

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
   
   b. *Pass & Seymour/Legrand (Pass & Seymour).*

2. Configuration: NEMA WD 6, Configuration L6-20R.

2.5 *TOGGLE SWITCHES, 120/277 V, 20 A*

A. Single-Pole Switches, 120/277 V, 20 A:

1. **Manufacturers:** Subject to compliance with requirements, provide products by the following:
   
   a. *Hubbell Incorporated; Wiring Device-Kellems.*
   b. *Leviton Manufacturing Co., Inc.*
   c. *Pass & Seymour/Legrand (Pass & Seymour).*

2. Standards: Comply with UL 20 and FS W-S-896.

B. Two-Pole Switches, 120/277 V, 20 A:

1. **Manufacturers:** Subject to compliance with requirements, provide products by the following:
   
   a. *Hubbell Incorporated; Wiring Device-Kellems.*
   b. *Leviton Manufacturing Co., Inc.*
   c. *Pass & Seymour/Legrand (Pass & Seymour).*

2. Comply with UL 20 and FS W-S-896.

C. Three-Way Switches, 120/277 V, 20 A:

1. **Manufacturers:** Subject to compliance with requirements, provide products by the following:
   
   a. *Hubbell Incorporated; Wiring Device-Kellems.*
   b. *Leviton Manufacturing Co., Inc.*
   c. *Pass & Seymour/Legrand (Pass & Seymour).*

2. Comply with UL 20 and FS W-S-896.

2.6 *OCCUPANCY SENSORS*

A. Wall Switch Sensor Light Switch, Dual Technology:
1. **Manufacturers:** Subject to compliance with requirements, provide products by the following:
   a. Hubbell Incorporated; Wiring Device-Kellems.
   b. Leviton Manufacturing Co., Inc.
   c. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Switchbox-mounted, combination lighting-control sensor and conventional switch lighting-control unit using dual (ultrasonic and passive infrared) technology.


4. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.

5. Adjustable time delay of 20 minutes.

6. Able to be locked to Manual-On mode.


8. Connections: Provisions for connection to BAS.


### PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:
   1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
   1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
   2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
   4. Existing Conductors:
      a. Cut back and pigtail, or replace all damaged conductors.
      b. Straighten conductors that remain and remove corrosion and foreign matter.
c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtailed that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtailed for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan-speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers’ device, listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.
3.3 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

C. Essential Electrical System: Mark receptacles supplied from the essential electrical system to allow easy identification using a self-adhesive label.

3.4 FIELD QUALITY CONTROL

A. Tests for Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

B. Test straight-blade for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz..

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 262726
SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Enclosures.

1.3 DEFINITIONS
A. NC: Normally closed.
B. NO: Normally open.
C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
   6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.
1.5 INFORMATIONAL SUBMITTALS

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

   a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
   b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Fuse Pullers: Two for each size and type.
3. 

1.8 QUALITY ASSURANCE

1.9 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year(s) from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with NFPA 70.

2.3 FUSIBLE SWITCHES

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

1. Eaton.
2. General Electric Company.
4. Square D; by Schneider Electric.

B. Type HD, Heavy Duty:

2. pole.
3. -V ac.
4. .
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses.
6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: type, suitable for number, size, and conductor material.
2.4 NONFUSIBLE SWITCHES

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

1. Eaton.
2. General Electric Company.
4. Square D; by Schneider Electric.

B. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: type, suitable for number, size, and conductor material.

2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1).

C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.

D. Operating Mechanism: The circuit-breaker operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

   1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 PREPARATION

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

   1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electric service.
   2. Indicate method of providing temporary electric service.
   3. Do not proceed with interruption of electric service without Construction Manager's written permission.
   4. Comply with NFPA 70E.

3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.

   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.
   3. Kitchen Areas: NEMA 250, Type 4X.

3.4 INSTALLATION

A. 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.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
E. Install fuses in fusible devices.

F. Comply with NFPA 70 and NECA 1.

3.5 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.6 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 to values indicated on the Drawings.

END OF SECTION 262816
SECTION 262913.03 - MANUAL AND MAGNETIC MOTOR CONTROLLERS

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:

2. Enclosed full-voltage magnetic motor controllers.
3. Combination full-voltage magnetic motor controllers.
4. Enclosures.
5. Accessories.

1.3 DEFINITIONS

A. CPT: Control power transformer.
B. MCCB: Molded-case circuit breaker.
C. MCP: Motor circuit protector.
D. NC: Normally closed.
E. OCPD: Overcurrent protective device.
F. SCCR: Short-circuit current rating.
G. SCPD: Short-circuit protective device.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
1.5 INFORMATIONAL SUBMITTALS

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For magnetic controllers to include in operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

   a. Routine maintenance requirements for magnetic controllers and installed components.
   b. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
   c. Manufacturer's written instructions for setting field-adjustable overload relays.
   d. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
   e. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses 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.
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. Indicating Lights: Two of each type and color installed.
4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.
6. .

1.8 QUALITY ASSURANCE

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
B. If stored in areas subject to weather, cover controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 50 W per controller.

1.10 FIELD CONDITIONS

A. Ambient Environment Ratings: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 23 deg F and not exceeding 104 deg F.
3. The effect of solar radiation is not significant.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. UL Compliance: Fabricate and label magnetic motor controllers to comply with UL 508 and UL 60947-4-1.

C. NEMA Compliance: Fabricate motor controllers to comply with ICS 2.

2.2 MANUAL MOTOR CONTROLLERS

A. Motor-Starting Switches (MSS): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Eaton.
   b. General Electric Company.
   c. Rockwell Automation, Inc.
   e. Square D; by Schneider Electric.

2. Standard: Comply with NEMA ICS 2, general purpose, Class A.
3. Configuration: Nonreversing.
4. Surface mounting.
5. Red pilot light.
B. Fractional Horsepower Manual Controllers (FHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
   a. Eaton.
   b. General Electric Company.
   c. Rockwell Automation, Inc.
   e. Square D; by Schneider Electric.

2. **Configuration:** Nonreversing.

3. **Overload Relays:** Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.

4. **Pilot Light:** Red.

C. Integral Horsepower Manual Controllers (IHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
   a. Eaton.
   b. General Electric Company.
   c. Rockwell Automation, Inc.
   e. Square D; by Schneider Electric.

2. **Configuration:** Nonreversing.

3. **Overload Relays:** Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.

2.3 COMBINATION FULL-VOLTAGE MAGNETIC MOTOR CONTROLLER

A. **Description:** Factory-assembled, combination full-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, SCPD and OCPD, in a single enclosure.

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

1. Eaton.
2. General Electric Company.
3. Rockwell Automation, Inc.
5. Square D; by Schneider Electric.

C. **Standard:** Comply with NEMA ICS 2, general purpose, Class A.
D. Configuration: Nonreversing.

E. Contactor Coils: Pressure-encapsulated type with coil transient suppressors when indicated.
   1. Operating Voltage: Manufacturer's standard, unless indicated.

F. Control Power:
   1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
      a. Spare CPT Capacity as Indicated on Drawings: 50 VA.

G. Overload Relays:
   1. Solid-State Overload Relay:
      a. Switch or dial selectable for motor-running overload protection.
      b. Sensors in each phase.
      c. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

H. Digital communication module, using RS-485 Modbus, RTU protocol, 2-wire connection to host devices with a compatible port] to transmit the following to the LAN:
   1. Instantaneous rms current each phase, and 3-phase average.
   2. Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.
   3. Active Energy (kWh): 3-phase total.
   4. Power Factor: Each phase and 3-phase total.
   5. .

I. Fusible Disconnecting Means:
   1. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
   2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.4 ENCLOSURES

A. Comply with NEMA 250, type designations as indicated on Drawings, complying with environmental conditions at installed location.

B. The construction of the enclosures shall comply with NEMA ICS 6.

C. Controllers in hazardous (classified) locations shall comply with UL 1203.
2.5 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty, except as needed to match enclosure type. Heavy-duty or oil-tight where indicated in the controller schedule.
   a. Push Buttons: As indicated in the controller schedule.
   b. Pilot Lights: As indicated in the controller schedule.

2. Elapsed Time Meters: Heavy duty with digital readout in hours; nonresettable.

3. Meters: Panel type, 2-1/2-inch minimum size with 90- or 120-degree scale and plus or minus two percent accuracy. Where indicated, provide selector switches with an off position.

B. Motor protection relays shall be with solid-state sensing circuit and isolated output contacts for hardwired connections.

1. Phase-failure.
2. Phase-reversal, with bicolor LED to indicate normal and fault conditions. Automatic reset when phase reversal is corrected.
3. Under/overvoltage, operate when the circuit voltage reaches a preset value, and drop out when the operating voltage drops to a level below the preset value. Include adjustable time-delay setting.

C. Space heaters, with NC auxiliary contacts, to mitigate condensation in Type 3R enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

D.  

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wall-Mounted Controllers: Install magnetic controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems" unless otherwise indicated.
C. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

F. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

END OF SECTION 262913.03
SECTION 262913.06 - SOFT-START MOTOR CONTROLLERS

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 soft-start motor controllers that are designed for reduced-voltage start and full-voltage run duty.

1. Enclosed soft-start controllers.
2. Combination soft-start controllers.

1.3 DEFINITIONS

A. CPT: Control power transformer.
B. FLA: Full-load current.
C. MCCB: Molded-case circuit breaker.
D. MCP: Motor circuit protector.
E. NC: Normally closed.
F. NO: Normally open.
G. OCPD: Overcurrent protective device.
H. SCCR: Short-circuit current rating.
I. SCPD: Short-circuit protective device.
J. SCR: Silicon-controlled rectifier.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
1.5 INFORMATIONAL SUBMITTALS

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For soft-start controllers to include in operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

   a. Routine maintenance requirements for soft-start controllers and installed components.
   b. Manufacturer's written instructions for testing and adjusting circuit-breaker and MCP trip settings.
   c. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage soft-start controllers.
   d. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate FLAs.
   e. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses 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.
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. Indicating Lights: Two of each type and color installed.
4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.
6. .

1.8 QUALITY ASSURANCE

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store soft-start controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect soft-start controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
B. If stored in areas subject to weather, cover soft-start controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 50 W per controller] connect factory-installed space heaters to temporary electrical service.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 32 deg F and not exceeding 104 deg F, humidity noncondensing.
2. Altitude: Not exceeding 3300 feet.
3. The effect of solar radiation is insignificant.
4. .

PART 2 - PRODUCTS

2.1 MOTOR CONTROLLER PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. UL Compliance: Fabricate and label enclosed controllers to comply with UL 508.

C. NEMA Compliance: Fabricate motor controllers to comply with NEMA ICS 2.

2.2 ENCLOSED SOFT-START MOTOR CONTROLLERS

A. Description: Controllers designed for reduced-voltage start, full-voltage run, and optional soft stop. The controller shall be an integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and user interface module, run-bypass contactor, and overload relay(s); suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.

1. Run-Bypass Contactor: Magnetic contactor in parallel with the SCR of the soft-start controller, bypassing the SCR when full voltage is achieved.

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

1. Eaton.
2. General Electric Company.
3. Rockwell Automation, Inc.
5. Square D; by Schneider Electric.
C. Standard: Comply with NEMA ICS 2, general purpose, Class A.

D. Configuration: Standard duty.

1. At least two SCRs per phase to control the starting and stopping of the motor.
2. Microprocessor control shall continuously monitor current and proper operation of the SCRs.
3. Bypass Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Soft-start controller protective features and deceleration controls shall remain active when this contactor is in the bypass mode.
4. Power Electronics Disconnect Contactor. Where indicated, installed ahead of the power electronics equipment, and shall open automatically when the motor is stopped, or a controller fault is detected, or when an SCR shorts.
5. Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.

E. Control Power:

1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
2. Spare CPT Capacity: As indicated on Drawings, available in increments of 100 VA, from 100 to 500 VA.

F. Controller Diagnostics and Protection:

1. Microprocessor-based thermal-protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
2. Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and under-load conditions; and line frequency over or under normal.
3. Input isolation contactor that opens when the controller diagnostics detect a faulted soft-start component or when the motor is stopped.
4. 

G. Cover mounted-controller status panel with LED lights or alphanumeric display to show the following:

1. Starter Status: "Ready," "starting," "stopping," or "run."
3. Faults:
   a. Motor overcurrent trip.
   b. Motor thermal overload.
   c. Starter thermal fault.
   d. Low line voltage.
   e. Loss of a phase.
   f. Phases reversed.
   g. Maximum stating time exceeded.
   h. Serial communications error.
H. Interface Panel: Mounted on controller door.

1. Guarded adjustable set points, not readily accessible.
   a. Motor FLA, adjustable from 40 to 110 percent of the controller's rating.
   b. Current limitation on starting, adjustable from 200 to 500 percent of FLA, typically set at 300 percent.
   c. NEMA ICS 2 overload class. Selections shall include the following tripping classes: Class 5, Class 10, Class 15, Class 20, and Class 30.

2. Adjustable set points, readily accessible.
   a. Linear acceleration, adjustable from 1 to 60 s.
   b. Maximum start time, adjustable from 1 to 250 s.
   c. Selector switch; select coast to stop or soft stop.
   d. Linear deceleration, adjustable from 1 to 60 s.

I. Remote Output Features. All outputs shall be prewired to terminal blocks.

1. Analog output for field-selectable assignment of motor operating characteristics; 4- to 20-mA dc.
2. Form C status contacts that change state when controller is running.
3. Form C alarm contacts that change state when a fault condition occurs.
4. .

J. Digital Communication Module: RS-485 Modbus, RTU protocol, 2-wire connection to host devices with a compatible port] to transmit the following to the LAN:

1. Instantaneous root mean square (rms) current each phase, and three-phase average.
5. .

2.3 COMBINATION SOFT-START MOTOR CONTROLLERS

A. Description: Factory-assembled, combination, reduced-voltage soft-start controller with a disconnecting means, SCPD and OCPD, in a single enclosure. The reduced-voltage soft-start controller shall consist of an integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and user interface module, run-bypass contactor, and overload relay(s); suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.

1. Run-Bypass Contactor: Magnetic contactor in parallel with the SCR of the soft-start controller, bypassing the SCR when full voltage is achieved.

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

1. Eaton.
2. General Electric Company.
3. Rockwell Automation, Inc.
5. Square D; by Schneider Electric.

C. Standard: Comply with NEMA ICS 2, general purpose, Class A.

D. Configuration: Standard duty.

1. At least two SCRs per phase to control the starting and stopping of the motor.
2. Microprocessor control shall continuously monitor current and proper operation of the SCRs.
3. Bypass Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Soft-start controller protective features and deceleration controls shall remain active when this contactor is in the bypass mode.
4. Power Electronics Disconnect Contactor. Where indicated, installed ahead of the power electronics equipment, and shall open automatically when the motor is stopped, or a controller fault is detected, or when an SCR shorts.
5. Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.

E. Control Power:

1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
2. Spare CPT Capacity: As indicated on Drawings, available in increments of 100 VA, from 100 to 500 VA.

F. Controller Diagnostics and Protection:

1. Microprocessor-based thermal-protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
2. Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and under-load conditions; and line frequency over or under normal.
3. Input isolation contactor that opens when the controller diagnostics detect a faulted soft-start component or when the motor is stopped.
4. 

G. Cover mounted-controller status panel with LED lights or alphanumeric display to show the following:

1. Starter Status: "Ready," "starting," "stopping," or "run."
3. Faults:
   a. Motor overcurrent trip.
   b. Motor thermal overload.
   c. Starter thermal fault.
d. Low line voltage.
e. Loss of a phase.
f. Phases reversed.
g. Maximum stating time exceeded.
h. Serial communications error.

H. Interface Panel: Mounted on controller door.

1. Guarded adjustable set points, not readily accessible.
   a. Motor FLA, adjustable from 40 to 110 percent of the controller's rating.
   b. Current limitation on starting, adjustable from 200 to 500 percent of FLA, typically set at 300 percent.
   c. NEMA ICS 2 overload class. Selections shall include the following tripping classes: Class 5, Class 10, Class 15, Class 20, and Class 30.
2. Adjustable set points, readily accessible.
   a. Linear acceleration, adjustable from 1 to 60 s.
   b. Maximum start time, adjustable from 1 to 250 s.
   c. Selector switch; select coast to stop or soft stop.
   d. Linear deceleration, adjustable from 1 to 60 s.

I. Remote Output Features: All outputs shall be prewired to terminal blocks.

1. Analog output for field-selectable assignment of motor operating characteristics; 4- to 20-mA dc.
2. Form C status contacts that change state when controller is running.
3. Form C alarm contacts that change state when a fault condition occurs.
4. .

J. Digital Communication Module: RS-485 Modbus, RTU protocol, 2 4-wire connection to host devices with a compatible port] to transmit the following to the LAN:

1. Instantaneous rms current each phase, and three-phase average.
5. .

K. Fusible Disconnecting Means:

1. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class J fuses.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
3. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wall-Mounted Controllers: Install controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on slotted support systems complying with Section 260529 "Hangers and Supports for Electrical Systems," and bolted to wall.

C. Freestanding Controllers: Provide slotted support systems complying with Section 260529 "Hangers and Supports for Electrical Systems."

D. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

F. Control Wiring: Separate control wiring from power wiring. Where unavoidable, use twisted pair cabling or shielded cables for control wiring.

G. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

H. Setting of Overload Relays: Select and set overloads on the basis of FLA rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for high-torque, high-efficiency, and so on motors.

3.3 IDENTIFICATION

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

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain motor controllers.

END OF SECTION 262913.06
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 the following types of LED luminaires:
   2. Downlight.
   3. Highbay, linear.
   4. Lowbay.
   5. Recessed, linear.
   7. Surface mount, linear.
   8. Suspended, linear.

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.
   2. Section 260926 "Lighting Control Panelboards" for panelboards used for lighting control.
   3. Section 260933 "Central Dimming Controls" or Section 260936 "Modular Dimming Controls" for architectural dimming systems and for fluorescent dimming controls with dimming ballasts specified in interior lighting Sections.
   4. Section 260943.16 "Addressable-Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.
F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Arrange in order of luminaire designation.
   2. Include data on features, accessories, and finishes.
   3. Include physical description and dimensions of luminaires.
   4. Include emergency lighting units, including batteries and chargers.
   5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
   6. Photometric data and adjustment factors based on laboratory tests, complying with IES "Lighting Measurements Testing and Calculation Guides" for each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project IES LM-79 and IES LM-80.
      a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
      b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

1.5 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
   2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
   3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.
1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the 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.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Ambient Temperature:

1. Relative Humidity: Zero to 95 percent.

B. Altitude: Sea level to 1000 feet.

2.2 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:
a. "USE ONLY" and include specific lamp type.
   b. Lamp diameter, shape, size, wattage, and coating.
   c. CCT and CRI.

C. Recessed luminaires shall comply with NEMA LE 4.

D. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

E. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

F. California Title 24 compliant.

2.3 MATERIALS

A. Metal Parts:
   1. Free of burrs and sharp corners and edges.
   2. Sheet metal components shall be steel unless otherwise indicated.
   3. Form and support to prevent warping and sagging.

B. Steel:
   1. ASTM A 36/A 36M for carbon structural steel.
   2. ASTM A 568/A 568M for sheet steel.

C. Stainless Steel:
   1. Manufacturer's standard grade.
   2. Manufacturer's standard type, ASTM A 240/240 M.

D. Galvanized Steel: ASTM A 653/A 653M.

E. Aluminum: ASTM B 209.

2.4 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.5 LUMINAIRE SUPPORT

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

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

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and 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. Flush-Mounted Luminaires:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.
F. Wall-Mounted Luminaires:
   1. Attached to structural members in walls.
   2. Do not attach luminaires directly to gypsum board.

G. Suspended Luminaires:
   1. Ceiling Mount:
      a. Two 5/32-inch-diameter aircraft cable supports adjustable to 10 feet in length.
      b. Pendant mount with 5/32-inch-diameter aircraft cable supports adjustable to 10 feet in length.
      c. Hook mount.
   4. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
   5. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

H. Ceiling-Grid-Mounted Luminaires:
   1. Secure to any required outlet box.
   2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
   3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

I. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

J. Fixture whips limited to 10’ to fixture from nearest junction box/fixture.

3.4 IDENTIFICATION

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

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
   2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Comply with requirements for startup specified in Section 260943.16 "Addressable-Luminaire Lighting Controls."

B. Comply with requirements for startup specified in Section 260943.23 "Relay-Based Lighting Controls."

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265119
SECTION 265213 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Emergency lighting units.
2. Exit signs.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.
B. CRI: Color Rendering Index.
C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
D. Fixture: See "Luminaire" Paragraph.
E. Lumen: Measured output of lamp and luminaire, or both.
F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.

1. Include data on features, accessories, and finishes.
2. Include physical description of the unit and dimensions.
3. Battery and charger for light units.
4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
   a. Testing Agency Certified Data: For indicated luminaires and signs, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires and signs shall be certified by manufacturer.
b. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

1.5 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Luminaire-mounted, emergency battery pack: One for every 20 emergency lighting units. Furnish at least one of each type.
3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two year(s) from date of Substantial Completion.

B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace
components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Power Unit Batteries: Five years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining four years.
2. Warranty Period for Self-Powered Exit Sign Batteries: Five years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining six years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.

C. Comply with NFPA 70 and NFPA 101.

D. Comply with NEMA LE 4 for recessed luminaires.

E. Comply with UL 1598 for fluorescent luminaires.

F. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.

1. Emergency Connection: Operate one LED lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire.
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.
5. Housing: NEMA 250, Type I enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly shall be located no less than half the distance recommended by the emergency power unit manufacturer, whichever is less.
6. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
7. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.3 EMERGENCY LIGHTING

A. General Requirements for Emergency Lighting Units: Self-contained units.

B. Emergency Lighting Unit:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   
   a. Cooper Lighting, an Eaton business.
   b. Dual-Lite.
   c. GE Lighting Solutions.
   d. Lithonia Lighting; Acuity Brands Lighting, Inc.

2. Emergency Lighting Unit: as indicated on Interior Luminaire Schedule.

3. Operating at nominal voltage of 120 V ac.

4. Wall with universal junction box adaptor.

5. UV stable thermoplastic housing.

6. Two LED lamp heads.

7. Internal emergency power unit.

2.4 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

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

   a. Cooper Lighting, an Eaton business.
   b. Hubbell Industrial Lighting; Hubbell Incorporated.
   c. Lithonia Lighting; Acuity Brands Lighting, Inc.
   d. Philips Lighting Company.

2. Operating at nominal voltage of 120 V ac.

3. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.

4. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.

2.5 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.

2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. 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 minimum unless otherwise indicated.

D. Housings:

1. Extruded aluminum housing.
2. powder coat finish.

E. Conduit: Electrical metallic tubing, minimum 3/4 inch in diameter.

2.6 METAL FINISHES

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 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 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

3.3 IDENTIFICATION

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

3.4 ADJUSTING

A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:

1. Inspect all luminaires. Replace lamps, emergency power units, batteries, signs, or luminaires that are defective.
   a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

2. Conduct short-duration tests on all emergency lighting.

END OF SECTION 265213
SECTION 265619 - LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.

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.
   2. Section 260926 "Lighting Control Panelboards" for panelboard-based lighting control.
   3. Section 260933 "Central Dimming Controls" or Section 260936 "Modular Dimming Controls" for architectural dimming systems specified in Section 265100.
   4. Section 260943.16 "Addressable-Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.
   5. Section 265613 "Lighting Poles and Standards" for poles and standards used to support exterior lighting equipment.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.
B. CRI: Color rendering index.
C. Fixture: See "Luminaire."
D. IP: International Protection or Ingress Protection Rating.
E. Lumen: Measured output of lamp and luminaire, or both.
F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.
1.4 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.
   1. Arrange in order of luminaire designation.
   2. Include data on features, accessories, and finishes.
   3. Include physical description and dimensions of luminaire.
   4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
   5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project IES LM-79 IES LM-80.
      a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
      b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
   6. Wiring diagrams for power, control, and signal wiring.
   7. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

1.5 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.
   1. Provide a list of all 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.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
   2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
   3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
   4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.
1.8 QUALITY ASSURANCE

A. Provide luminaires from a single manufacturer for each luminaire type.

B. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

C. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.10 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.11 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures, including luminaire support components.
   b. Faulty operation of luminaires and accessories.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   d. .

2. Warranty Period: 2 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. UL Compliance: Comply with UL 1598 and listed for wet location.

E. Lamp base complying with ANSI C81.61 or IEC 60061-1.

F. Bulb shape complying with ANSI C79.1.

G. CRI of minimum 80. CCT of 3000 K.

H. L70 lamp life of 35,000 hours.

I. Lamps dimmable from 100 percent to 0 percent of maximum light output.

J. Internal driver.

K. Nominal Operating Voltage: 120 V ac.

L. In-line Fusing: On the primary for each luminaire.

M. Lamp Rating: Lamp marked for outdoor use and in enclosed locations.

N. Source Limitations: Obtain luminaires from single source from a single manufacturer.

O. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.3 LUMINAIRE TYPES

A. Area and Site:

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

   a. [Architectural Area Lighting](#).
   b. [Cooper Lighting, an Eaton business](#).
   c. [GE Lighting Solutions](#).
   d. [H.E. Williams](#).
   e. [KIM Lighting](#).
   f. [Lightolier: a Philips group brand](#).
   g. [Lithonia Lighting: Acuity Brands Lighting, Inc.](#).
   h. [OSRAM SYLVANIA](#).

2. Luminaire Shape: Square.

3. Mounting: Building with arm, 11 inches in length.

4. Luminaire-Mounting Height: .
5. Distribution: Type III.
7. Housings:
   a. Extruded-aluminum housing and heat sink.
   b. Powder-coat finish.

2.4 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Corrosion-resistant aluminum. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

D. Diffusers and Globes:
   1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   2. Glass: Annealed crystal glass unless otherwise indicated.
   3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.

G. Housings:
   1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
   2. Provide filter/breather for enclosed luminaires.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp characteristics:
      a. "USE ONLY" and include specific lamp type.
      b. Lamp diameter, shape, size, wattage and coating.
c. CCT and CRI for all luminaires.

2.5 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Examine walls, roofs, and canopy ceilings and overhang ceilings for suitable conditions where luminaires will be installed.

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

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.
B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Install lamps in each luminaire.

D. Fasten luminaire to structural support.

E. 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.

F. Wall-Mounted Luminaire Support:
   1. Attached to structural members in walls.


H. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at height and aiming angle as indicated on Drawings.

I. Coordinate layout and installation of luminaires with other construction.

J. Adjust luminaires that require field adjustment or aiming.

K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

A. Aim as indicated on Drawings.

B. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.5 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 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.
3.6 IDENTIFICATION

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

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaires.

3.8 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265619
SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

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. Category 6 twisted pair cable.

B. Related Requirements:
   1. Section 270513 "Conductors and Cables for Communications Systems" for data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. FTP: Shielded twisted pair.

D. F/FTP: Overall foil screened cable with foil screened twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. LAN: Local area network.

H. Jack: Also commonly called an "outlet," it is the fixed, female connector.

I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
M. S/FTP: Overall braid screened cable with foil screened twisted pair.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

1.4 COPPER HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as “Cabling Subsystem 1,” in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 sq. ft., and includes the components that extend from the equipment outlets to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.

B. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

1.8 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 Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Test cables upon receipt at Project site.
1. Test each pair of twisted pair cable for open and short circuits.

1.10 PROJECT CONDITIONS
A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION
A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS
A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated: Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway.
LaBella Associates, D.P.C. Canisteo-Greenwood CSD February, 2019
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2. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

3. Communications, Non-plenum: Type CMR complying with UL 1666 and ICEA S-103-701.

4. Communications, Non-plenum: Type CMP or Type CMR in listed plenum or riser communications raceway.

5. Communications, Non-plenum: Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. RoHS compliant.

2.3 CATEGORY 6 TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.

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

1. 3M.
2. AMP NETCONNECT; a TE Connectivity Ltd. company.
3. Belden CDT Networking Division/NORDX.
4. General Cable; General Cable Corporation.


D. Conductors: 100-ohm, 23 AWG solid copper.

1. <Double click to insert sustainable design text for lead content.>

E. Shielding/Screening: Shielded twisted pairs (FTP).

F. Cable Rating: Plenum.

G. Jacket: Yellow thermoplastic.
PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. 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. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."

B. Comply with Section 270528 "Pathways for Communications Systems."

C. Comply with Section 270529 "Hangers and Supports for Communications Systems."

D. Comply with Section 270536 "Cable Trays for Communications Systems."

E. Drawings indicate general arrangement of pathways and fittings.

3.3 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
6. MUTOA shall not be used as a cross-connect point.
7. Consolidation points may be used only for making a direct connection to equipment outlets:
   a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
   b. Locate consolidation points for twisted-pair cables at least 49 feet from communications equipment room.
8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.

10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.

11. 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.

12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

13. In the communications equipment room, install a 10-foot-long service loop on each end of cable.


C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.

3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.

2. Install cabling after the flooring system has been installed in raised floor areas.

3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper 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:


   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.


3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
3.4 FIREFSTOPPING
   A. Comply with requirements in Section 078413 "Penetration Firestopping."
   B. Comply with TIA-569-D, Annex A, "Firestopping."

3.5 GROUNDING
   A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
   B. Comply with TIA-607-B and NECA/BICSI-607.
   C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.
   D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION
   A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
   1. Administration Class: Class 1.
   2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration.

C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:
   1. Label each cable within 4 inches 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 the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
   3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
   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, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
   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.

F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
   1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:
   1. Visually inspect 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 TIA-568-C.1.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test twisted pair 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 TIA-568-C.2. 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.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 271513
SECTION 284621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. System smoke detectors.
      2. Heat detectors.
   B. Related Requirements:
      1. Section 271513 "Communications Copper Horizontal Cabling" for cables and conductors for fire-alarm systems.

1.3 DEFINITIONS
   A. EMT: Electrical Metallic Tubing.
   B. FACP: Fire Alarm Control Panel.
   C. HLI: High Level Interface.
   E. PC: Personal computer.
   F. VESDA: Very Early Smoke-Detection Apparatus.

1.4 ACTION SUBMITTALS
   A. 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.
1.5 INFORMATIONAL SUBMITTALS

1.6 CLOSEOUT SUBMITTALS

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. 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, Fire 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 tamperproofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.
8. Filters for Air-Sampling Detectors: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
9. Air-Sampling Fan: Quantity equal to one for every five detectors, but no fewer than one unit of each type.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.

C. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.9 PROJECT CONDITIONS

A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.

B. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of fire-alarm service.
2. Do not proceed with interruption of fire-alarm service without Construction Manager's written permission.

C. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.10 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.

B. Automatic sensitivity control of certain smoke detectors.

C. All components provided shall be listed for use with the selected system.

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 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Heat detectors.
2. Smoke detectors.
3. Carbon monoxide detectors.
B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances, including voice evacuation notices.
2. Identify alarm and specific initiating device at fire-alarm control unit, connected network control panels, off-premises network control panels, and remote Annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Release fire and smoke doors held open by magnetic door holders.
5. Activate voice/alarm communication system.
6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
7. Recall elevators to primary or alternate recall floors.
8. Activate emergency shutoffs for gas and fuel supplies.
9. Record events in the system memory.
10. Record events by the system printer.
11. Indicate device in alarm on the graphic annunciator.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. User disabling of zones or individual devices.
2. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.

E. System Supervisory Signal Actions:

1. Identify specific device initiating the event at fire-alarm control unit, connected network control panels, off-premises network control panels, and remote Annunciators.
2. Record the event on system printer.
3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
4. Display system status on graphic annunciator.

2.3 PERFORMANCE REQUIREMENTS

2.4 SYSTEM SMOKE DETECTORS

A. Manufacturers: compatible with existing fire alarm systems to remain:

B. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be two-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
   a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
   b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
   c. Multiple levels of detection sensitivity for each sensor.
   d. Sensitivity levels based on time of day.

C. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
e. Sensor range (normal, dirty, etc.).
3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

2.5 HEAT DETECTORS

A. Manufacturers: compatible with existing fire alarm systems to remain:

B. General Requirements for Heat Detectors: Comply with UL 521.
   1. Temperature sensors shall test for and communicate the sensitivity range of the device.

C. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
   1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

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 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all 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 all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the supervising station.
3. Expand, modify, and supplement existing control equipment as necessary to extend existing control functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

C. Equipment Mounting: Install fire-alarm control unit 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 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 supported equipment.

D. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

E. Smoke- or Heat-Detector Spacing:

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.
5. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

F. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

G. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall 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.

H. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

I. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

J. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

K. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.3 PATHWAYS

A. Pathways above recessed ceilings and in nonaccessible locations may be routed exposed.
   1. Exposed pathways located less than 96 inches above the floor shall be installed in EMT.

B. Pathways shall be installed in EMT.

C. Exposed EMT shall be painted red enamel.

3.4 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 a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
   1. Alarm-initiating connection to smoke-control system (smoke management) at firefighters' smoke-control system panel.
   2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
   3. Smoke dampers in air ducts of designated HVAC duct systems.
   4. Magnetically held-open doors.
   5. Electronically locked doors and access gates.
   6. Alarm-initiating connection to elevator recall system and components.
   7. Alarm-initiating connection to activate emergency lighting control.
   8. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
10. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
11. Supervisory connections at elevator shunt-trip breaker.
12. Data communication circuits for connection to building management system.
13. Data communication circuits for connection to mass notification system.
15. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
16. Supervisory connections at fire-pump engine control panel.

3.5 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 a location visible from fire-alarm control unit.

3.6 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall 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 shall be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

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. It is the intent of this section to limit the area of clearing and grubbing to the minimum area possible to allow for the proper installation of the work and to preserve all plantings, trees, shrubs, grass, and natural vegetation to the maximum extent possible.
   2. Provide stripping and stockpiling of topsoil.
   3. Prune existing trees and plants affected by the execution of the work.
   4. Provide clearing and grubbing of all trees, plants, undergrowth, shrubs, brush, other vegetation and debris within the limits indicated on the Contract Drawings and as required to complete the work.
   5. Protect existing trees and plants scheduled to remain.
   6. Remove all fence, sidewalk, granite curb, concrete curb, asphalt pavement, concrete pavement, utility structures, pipes, conduits, site lighting, utility poles and other items as indicated on the Contract Drawings or as needed to complete the work.
   7. Disconnect, cap or seal, and remove and/or abandon site utilities in place. Provide bypassing of flows as needed to complete and protect the work.
   8. Properly dispose of all removed materials not designated to be reused or delivered to the Owner.
   9. Fill and properly compact voids left from clearing and grubbing and buried utility removal activities with backfill materials to meet the finished treatments. (Refer to Part 3 “Clearing and Grubbing”)

B. Related Sections:
   1. Division 31 Section “Earth Moving”
   2. Division 31 Section “Erosion and Sediment Control”

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically 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 and is 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 more than 2 inches in diameter; and free of subsoil and weeds, roots, materials toxic to plant growth, or other nonsoil materials. These soils typically need to be screened and amended before satisfying the requirements of topsoil for landscaping purposes.

D. Plant-Protection Zone: Area surrounding planting beds, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated.

F. Caliper: Diameter of a trunk measured by a diameter tape at 6 inches (150 mm) above the ground for trees up to, and including, 4-inch (100-mm) size; and 12 inches (300 mm) above the ground for trees larger than 4-inch (100-mm) size.

G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other 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 SUBMITTALS

A. Submit name and qualifications of certified Arborist and tree service firm to be utilized.

B. Tree Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction. Data shall include:

1. Species and size of tree.
2. Location on site plan. Include unique identifier for each.
3. Reason for pruning.
4. Description of pruning to be performed.
5. Description of maintenance following pruning.

C. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.

D. Certification: From arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.
E. Existing Conditions: Documentation of existing trees and plantings, indicated to remain and adjoining construction and/or site improvements which establishes preconstruction conditions that might be misconstrued as damage caused by site clearing or other construction related activities.

1. Use sufficiently detailed photographs or videotape.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

F. Label or pruning paint data proposed for use.

G. Antirust coating data proposed for use.

H. Contractor’s schedule indicating dates upon which Contractor and Owner’s Designated Representative will traverse the site to allow Contractor to indicate the trees and plantings which he has determined to be necessary to remove, trimmed, or replanted and to obtain Owner’s Designated Representative’s approval.

I. Detailed plan on handling of bypass flows during construction including equipment and methods proposed, timeline, crews and contingency plan. This plan will be reviewed by the Architect/Engineer and no bypass operations will be permitted without an approved plan.

J. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

A. Arborist Qualifications: Certified Arborist as certified by ISA.

B. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this project and that will assign an experienced, qualified arborist to project site during execution of the work.

1. Review methods and procedures related to temporary tree and plant protection including, but not limited to, the following:

   a. Construction schedule. Verify availability of materials, personnel, and equipment needed to make progress and avoid delays.
   b. Enforcing requirements for protection zones.
   c. Arborist's responsibilities.
   d. Field quality control.

C. Confine clearing and grubbing operations to within the limits shown on the Contract Drawings or as otherwise designated by the Architect/Engineer. General limits include:

1. All areas where work is required to be done, but, to the minimum extent possible to properly install the work.
2. Within the grading limits shown on the Drawings.
3. Within existing public rights-of-way or easement.
D. No trees, plants, shrubs, flowers or vegetation shall be removed or trimmed without prior permission of the Architect/Engineer or Owner’s Designated Representative, except where otherwise specified or directed.

E. Pruning of trees shall be completed by a trained arborist.

F. Provide at least one person who shall be present at all times during clearing and grubbing operations who shall be thoroughly familiar with the following:
   1. The types of trees and plantings encountered.
   2. The proper procedures and methods for preserving trees.
   3. The proper procedures and methods for felling, trimming, pruning, and caring for trees and plants and their roots.

Such person(s), firm(s), or subcontractor(s) must be totally familiar with this type of work, must be regularly engaged in similar work and shall be responsible for directing all work affecting trees, plantings, and vegetation.

G. Comply with all applicable local, state, and federal requirements regarding materials, methods of work, and disposal of excess and waste materials.

H. Erosion control measures in accordance with Division 31 Section “Erosion and Sediment Control”, the Project SWPPP, and the NYSDEC SPDES General Permit for Stormwater Discharges from Construction Activity (GP-0-10-001) shall be followed.

I. Obtain and pay for all required inspections, permits, and fees. Provide notices required by governmental authorities.

1.7 PROJECT CONDITIONS

A. Burning or burial of materials at the site is not permitted.

B. Explosives are not permitted for clearing and grubbing operations.

C. Minimize interference with adjoining roads, streets, walks, parking areas and other adjacent occupied or used facilities during site-clearing operations. Refer to Division 32 Section “Maintenance and Protection of Traffic” for traffic maintenance information.

D. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property, if any will be obtained by Owner before award of Contract.
   1. Do not proceed with work on adjoining property until directed by Owner’s Designated Representative.

E. No grubbing shall be allowed along the side slopes of the embankments.

F. All clearing and grubbing within 5-feet of the embankments shall be performed by pulling debris, sediment or any other materials away from the embankment slope to help protect the downhill areas. No materials within this area shall be pushed down the embankment slope.
G. Notify Dig Safely New York (UFPO) prior to commencing any excavation. Locate and identify existing underground and overhead services and utilities within contract limit work areas. Provide adequate means of protection of utilities and services, which are not designated to be removed. Repair utilities damaged during site work operations at Contractor’s expense.

H. The Project Site Owner is not a member of Dig Safely New York. The Contractor alone shall be responsible to locate all utilities and services outside the public rights-of-way. The Contractor shall complete test pits as needed to confirm underground utilities and services. The cost of all test pits shall be included in the price bid. Provide adequate means of protection of utilities and services, which are not designated to be removed. Repair utilities damaged during site work operations at Contractor’s expense.

I. Arrange for disconnection, disconnect, and seal or cap all utilities and services designated to be removed before start of site work operations. Perform all work in accordance with the requirements of the applicable utility company or agency involved. The Contractor shall pay all costs for all utility related work including coordination with and charges from the utility company for work they may require in order to accomplish the work shown or implied.

J. Should uncharted or incorrectly charted underground piping or other utilities and services be encountered during site work operations, notify the applicable utility company or utility owner immediately to obtain utility company/owner in maintaining active services in operation. The Contractor shall bear the cost of any and all repair work.

K. Locate, protect, and maintain benchmarks, monuments, control points, and project engineering reference points. Reestablish disturbed or destroyed items at Contractor’s expense.

L. The control of dust, noise, erosion, and sediment originating from construction operations is considered a critical responsibility of the Contractor. The Owner’s Designated Representative will be the final judge of the adequacy of the Contractor’s dust, noise, erosion, and sedimentation control. Work may be suspended by the Owner’s Designated Representative until adequate dust, noise, erosion, and sedimentation control is attained.

M. Protect existing buildings, paving, and other services or facilities on site and adjacent to the site from damage caused by site work operations. Cost of repair and restoration of damaged items at Contractor’s expense.

N. The location and size of trees, plantings, vegetation, as well as location, size and material of construction of drives, sidewalks, curbs, fences, existing utilities and other living and non-living items, as shown on the Drawings, have been determined by actual surveys at the time surveys were made. Since that time, additional items may have been built, modified, improved or planted, some items may have been removed or replaced, and the condition of things may have changed.

O. The contract cost shall also include restoration of all disturbed or damaged areas with in-kind materials at the time of construction, whether shown on the Contract Drawings or not, unless otherwise indicated in the Contract Documents.

P. Protect and maintain streetlights, parking and sidewalk lighting, emergency phones, utility poles and services, curb boxes, valves, utility structure/piping castings, and other services, except items designated for removal.
Q. The Contractor shall take precautions to protect from harm the work of other contractors on site, existing facilities, as well as adjacent property. The Contractor shall be responsible for all damage or injury done to pipes, structures, pavement, site amenities, utility features, property or person as a result of work performed to complete this contract. The Contractor at his own expense shall repair or replace such property or item to the satisfaction of the property owner, utility owner, public agency having jurisdiction and/or Architect/Engineer and Owner’s Designated Representative.

R. When it is necessary to haul materials over public or private streets, roads, drives, parking areas, walkways or other pavements, the Contractor shall provide suitable tight vehicles so as to prevent deposits on these pavements. In all cases, where any materials are dropped from the vehicles, the Contractor shall clean up the same as often as directed and keep the crosswalks, streets, roads, drives, parking areas, walkways, and drainage ways (e.g. swales, ditches, gutters, catch basins, manholes, piping, etc.) clean and free from dirt, mud, stone, and other hauled materials.

S. Responsibility for cleaning private and public; roads, drives, parking areas or walkways, of any material carried onto these roads or other pavements by trucks or other equipment, completing work in support of this project, shall be the Contractor's and cost shall be included in price bid.

T. The following practices are prohibited within tree- and plant-protection zones:
   1. Storage or stockpiling of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Foot traffic.
   4. Erection of sheds or structures.
   5. Impoundment of water.
   6. Excavation or other digging, unless otherwise indicated.
   7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
   8. Do not direct vehicle or equipment exhaust towards protection zones.
   9. Prohibit heat sources, flames, and ignition sources within or near protection zones.
   10. Do not store materials potentially harmful to tree roots. Potentially harmful materials include, but are not limited to: petroleum products; cement; lime; paints; detergents; acids; and, cleaning agents.

U. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

1.8 STORAGE AND HANDLING

A. Stockpiling of earth spoil or excess earth material on the site or storage of excavated materials for reuse shall be done in a manner which will not hinder the progress of the work; cause any nuisance; or cause spillage or tracking of materials from the transporting vehicle onto public or private roadways and pavements, or cause an inconvenience to adjacent property owners or the active campus facility.

B. Obstruction of roads, driveways, parking areas, sidewalks, or interference with drainage along curbs, ditches, or drainage channels with stored material is not permitted.

C. Store fences, signs, granite curb and other items at approved locations for subsequent reinstallation.
D. Promptly remove materials not specified to be stored or reused.

1.9 SCHEDULING

A. Avoid interference with the use of, and passage to and from, adjacent properties, buildings, facilities, driveways, walks, drainage systems, and roads etc.

B. Do not commence site clearing operations until temporary erosion- and sedimentation-control and tree- and plant-protection measures are in place.

C. Pavements which are required to be removed, including streets, roadways, driveways, parking areas, and walkways, may be saw cut in advance, but do not remove until the work is ready to be installed.

D. Do not remove signs, guide rails, and all other control, safety and warning devices until just prior to the installation of the work.

E. Do not remove fences until the property owners affected are notified at least four days in advance of such removal. Unless written permission from a fence owner is received, do not remove a fence more than 48 hours in advance of the installation of the work affected by the fence.

F. It is the intent of this section that all items affecting traffic, safety, lives, and the containment of humans and animals and all items essential to the protection of property or the operation of a business be left in place as long as possible and replaced as soon as possible when such items must be removed.

1.10 PROTECTION AND COORDINATION

A. Persons and Property:

1. Carefully protect and guard all trees, shrubs, and vegetation to remain.

2. Take every precaution to avoid damage to utilities, buildings, structures, facilities, and other property. All curbs, gutters, pavements, structures, utility lines, and other features along the street rights-of-way, adjacent property and the existing campus facility shall be protected.

3. Barricades/Enclosures: Properly protect persons and property at all times against harm or damage of any kind during construction and site improvement operations. Provide substantial barricades/enclosures around all openings as soon as they are uncovered, to block access and afford protection to workmen, facility employees, and the general public.

4. Signals: Provide lanterns or other signalization, as may be required by law or directed by the Owner’s Designated Representative in the vicinity of any open excavations or unsafe areas, and be certain that such devices are operable at all times during hours of darkness, or when the work area is left unattended.

5. Shoring/Bracing: Provide necessary shoring and bracing for support of buildings scheduled for demolition and for protection of adjacent structures and facilities caused by demolition operations. Cost of repair shall be paid by the Contractor and at no additional cost to the Owner.

6. Maintain all barricades and signals for the duration of the Contract.
B. Utilities:

1. Preserve Active Lines: Preserve in operating condition, all active utilities indicated on the Contract Drawings to remain. This applies to all utilities, which traverse the project site, or exist in the immediate vicinity of the site, including, but not limited to, mains, conduits, manholes, handholes, catch basins, valve boxes, poles, guy anchors, and appurtenances. Damage to any utility line or related appurtenances resulting from work under this Contract shall be repaired or replaced by the Contractor to the satisfaction of the Architect/Engineer, Owner, utility company, utility owner and/or local authority. All costs associated with this repair shall be paid by the Contractor at no additional cost to the Owner.

2. Damaged Utility Lines: If active utility lines are broken or damaged during any site improvements operations, take all necessary steps immediately to avoid endangering persons or property, and notify the Owner’s Designated Representative, Architect/Engineer, and the affected utility company, and municipal engineer’s office to obtain a decision regarding this treatment and/or assistance in the repair of the damaged line.

3. Prior Notification: Notify all utility companies, utility owners, municipal engineer’s office, and/or the respective water and sewer department, prior to the commencement of any operations on the site. Confirm locations with all utility companies/owners involved, of all live or active lines within, or immediately adjacent to, the contract limit lines of this project.

4. Water Damage: In the event that water, storm sewer, sanitary, or other utility lines are broken, or that springs, ground water, or other sources of water are encountered, take all necessary steps immediately to divert water away from construction, site improvement operations and storage areas to prevent erosion, undermining or other damage. If permanent corrective measures other than those indicated on the Contract Drawings become necessary, request a written decision from the Architect/Engineer.

C. Adjacent Properties:

1. Protection: Protect all adjacent properties and structures and use every means possible to prevent erosion, flooding, undermining excessive excavation or other damage during any construction or site improvement operations. Repair all damage in a manner specified by, and to the satisfaction of the Owner’s Designated Representative and the Architect/Engineer. The Contractor shall pay the cost of any repairs necessary at no additional cost to the Owner.

D. Restoration:

1. Injured or damaged trees shall be repaired in accordance with accepted nursery industry standards and as acceptable to the Architect/Engineer.

2. Contractor shall bear the cost of repair and replacement of trees scheduled to remain that are damaged or removed by construction operations.

3. All trees, shrubs or plantings, which are taken-up for subsequent reuse, and die, shall be replaced with first class balled and burlapped nursery grown representatives of the same species and caliper at the expense of the Contractor.

4. Damage to existing curbs, gutters, pavements, structures, utility lines, or other features should be replaced or repaired to the satisfaction of the Architect/Engineer, Owner’s Designated Representative, and/or utility owner, at no additional cost to the Owner.

5. Fill, grade, and compact disturbed areas to the grades and lines as shown on the Contract Drawings. Grade compacted surface to meet adjacent grades and provide proper surface
drainage. Provide uniform levels and slopes. All work shall be completed in accordance with specification Division 31 Section “Earth Moving”.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Asphalt base paint specially formulated for horticultural application to cut or damaged plant tissue.

B. Satisfactory Soil and Granular Material: Requirements for satisfactory soil and granular materials are specified in Division 31 Section "Earth Moving."
   1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.
   2. Provide imported granular materials.
   3. Provide imported topsoil.

C. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating.
   1. Use coating with a VOC content of 3.5 lb/gal. or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:
   1. Type: Shredded hardwood.
   2. Size Range: 3 inches maximum, 1/2 inch minimum.

E. Tree- and Plant- Protection Zone Fencing:
   1. The Contractor is to furnish all labor, materials, equipment, and supplies and perform all operations required to complete this work.
   2. Protection zone fencing shall be temporary orange construction fence, a minimum of 4-feet in height, mounted to 2-inch x 4-inch wood or steel fence posts, set a maximum of 10 feet o.c. Fence enclosure shall be defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated or as determined by the arborist, whichever is greater.

PART 3 - EXECUTION

3.1 PREPARATION

A. Monuments: Locate, protect and maintain benchmarks, monuments, batter boards, survey control points and other reference points from disturbance during construction. Protect all reference
points against movement, injury, and displacement and replace those, which become disturbed as the result of any operations of this Contract. Monuments, benchmarks, and other reference features shall be carefully protected by Contractor. Should any be disturbed or damaged by any cause, the Contractor shall have same replaced to original location, elevation and condition by a NYS Licensed Land Surveyor at the cost and expense of the Contractor.

B. Verify all limiting boundaries such as permanent and temporary easements, property lines, rights-of-way and grading limits have been accurately located and clearly marked. Where appropriate, verify that pipeline routings and other work limits have been accurately located and clearly marked.

C. Locate and clearly identify trees, shrubs, and other vegetation to be removed or relocated. Wrap a 1-inch blue vinyl tie tape flag around each tree trunk at 54+/- inches above the ground.

D. Carefully plan and execute operations so as to avoid damage to trees, shrubs, plants, etc.

E. Verify that temporary erosion- and sedimentation-control measures are in place.

F. Protect existing site improvements to remain from damage during construction.
   1. Restore damaged improvements to their original condition, as acceptable to Owner’s Designated Representative.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Work shall be completed in accordance with Division 31 Section “Erosion and Sediment Control”, the Project SWPPP and SPDES General Permit for Stormwater Discharges from Construction Activity (GP-0-10-001).

B. Comply with all federal, state, and local laws, ordinances, rules, and regulations.

C. 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.

D. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

E. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

F. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. Prior to the start of any site operations, fence all trees and groups of trees, shrubs or planting beds which may interfere with site operations and are not designated to be removed. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other
vehicular circulation. Maintain fencing during full construction period. Remove temporary fencing when no longer needed or when acceptable to the Architect/Engineer.

B. Protect trees against cutting, breaking, bruising of bark. Where, in the opinion of the Architect/Engineer, the Contractor does not exercise reasonable care, the Architect/Engineer may require trunks to be wrapped with protective fencing.

C. Tie back flexible limbs that may be damaged by passage or activity of equipment beneath trees. Where limbs cannot be tied back and equipment cannot avoid limbs or branches, prune back limbs, only after approval of the Architect/Engineer.

D. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

E. If recommended by the Arborist, mulch areas inside tree-protection zones and other areas indicated. Apply 4-inch average thickness of organic mulch. Do not place mulch within 6-inches of tree trunks.

F. Protect Tree- and Plant- Protection Zones. Refer to Part 1 “Project Conditions” for additional information.

G. Maintain protection zones free of weeds and trash. Mow grass as needed to maintain a 2-to 4-inch grass height.

H. Trenching near Trees: Obtain arborist approval for work required in root zones and protection zones. Where utility trenches are required within protection zones, hand excavate under or around tree roots or tunnel under the roots by drilling, auger boring, or pipe jacking. Tunnel past established trees for a minimum distance of 7 feet each side of the trunk. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning.

I. Redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches back from new construction and as required for root pruning.

J. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

K. Prune roots that are affected by temporary and permanent construction.

1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.

2. Cut Ends: Coat cut ends of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other coating formulated for use on damaged plant tissues and that is acceptable to arborist.
3. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
4. Cover exposed roots with burlap and water regularly.
5. Backfill as soon as possible according to requirements in Division 31 Section "Earth Moving."

L. Root Pruning at Edge of Protection Zone: Prune roots 12 inches outside of the protection zone, by cleanly cutting all roots to the depth of the required excavation.

M. Root Pruning within Protection Zone: Clear and excavate by hand to the depth of the required excavation to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

N. The Contractor will be held responsible for damage to trees as a result of not following the procedures outlined herein, not exercising reasonable care or by negligence.

O. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect/Engineer or Owner’s Designated Representative.

P. Dead or Dying Trees:
   1. All trees, which, upon completion of the project, are found to be in a dead or dying condition (more than 50% dead or in an unhealthy condition) as the result of the failure to adhere to the above precautionary measures, shall be removed to 12 inches below finished grade and replaced, in a designated location, with a tree of like size and species at the expense of the Contractor. The tree shall be guaranteed for a period of 12 months or the project’s guarantee period, whichever is longer.

Q. Damaged Trees:
   1. Trees damaged in any manner, but deemed savable, may be repaired to the satisfaction of the Architect/Engineer, by an approved tree surgery company.
   2. Should the repaired tree(s) die within 12 months of final acceptance of the project, the tree(s) shall be removed and replaced as above.

R. Relocation of Trees/Shrubs/Plants:
   1. Dig trees/shrubs/plants during appropriate season and plant immediately in the designated location. Should it be necessary, due to the sequence of work, to delay planting in the new permanent location, dig and store tree/shrubs/plants in accordance with accepted standard practices. Trees may be dug with a tree spade, but must be planted immediately in the permanent or an approved temporary location.

3.4 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
   1. Notify applicable utility company or utility owner and obtain approval for shutting off and terminating existing utility services.
2. Perform work in accordance with applicable utility company requirements.
3. Identify utility service terminations on project record documents. Place markers to indicate location of disconnected utility service below grade.
4. Notify Owner’s Designated Representative in writing when disconnecting and sealing/capping of each utility service is complete.

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. The Contractor shall coordinate at least two weeks in advance with the Architect/Engineer, the Campus, and Owner’s Designated Representative to schedule temporary service shut downs needed to complete the work.
2. Notify Owner’s Designated Representative and Owner in writing not less than 48-hours in advance to confirm proposed utility interruptions.
3. Any one disruption shall not exceed 4-hours unless mutually agreed to by the Owner, Owner’s Designated Representative, Architect/Engineer and Contractor.
4. Temporary service shutdown durations, time of day, and day of the week will be restricted by the Owner. Temporary power, water or sanitary shutdowns will not be permitted during normal weekday business hours for the facility/campus. The Contractor shall include in the price bid all costs for labor, equipment and materials necessary to complete the connections when the facility/campus is not in operation (e.g. weekends, holidays, or if approved by the facility/campus weekdays between 5:00 p.m. and 6:00 a.m.). The date, time and duration of any service shutdown shall be mutually agreed upon between the Contractor, Owner's Designated Representative, the Campus, and Architect/Engineer, prior to start of work.
5. Do not proceed with utility interruptions without Owner’s Designated Representative written permission.

C. Excavate for and remove underground utilities indicated to be removed.

D. Provide bypassing of flows as needed.

3.5 CLEARING AND GRUBBING

A. The Contractor shall schedule and conduct his operations to minimize erosion of soils and to prevent silting and muddying of streams, rivers, wetlands, impoundments and land adjacent to or affected by the work. Erosion control measures shall be implemented and the area of soil exposed by construction at any one time shall be kept to a minimum. Final restoration shall be carried out as soon as possible following completion of clearing and grubbing operations.

B. Contractor shall protect all existing site utilities, appurtenance and amenities to remain.

C. All operations shall be done in a manner so that present growth will blend with the limits of construction and a natural appearance will be attained.

D. Clearing consists of cutting and properly disposing of all trees (designated to be removed) and other vegetation, down timber, snags, stubs, brush, shrubs, bushes, as well as boulders, rubbish, debris, and other objectionable matter and materials occurring within areas to be cleared.
E. In wooded areas, trees may be removed and/or trimmed as required, for the proper installation of the work. Gross and unnecessary removal of trees is not permitted.

F. Grubbing consists of the removal and proper disposal of all stumps, roots, duff, grass, turf, sod, debris, vegetation, foundations, buried structures and pipes, as well as other objectionable matter and materials occurring within the areas to cleared and grubbed.

G. Remove stumps and roots to their full depth within 5-feet of underground structures, utility lines, footings and concrete or paved surfaces. Remove stumps and roots to a clear depth of 3-feet below subgrade in other locations.

H. Use hand method for grubbing within protection zones of trees to remain.

I. Stumps of trees removed shall be grubbed, ground or cut.

J. All stump holes shall be backfilled and properly compacted to the satisfaction of the Owner’s Designated Representative and/or Architect/Engineer. Backfill materials shall include: granular materials meeting NYSDOT Item 304.14 in areas under and within 5 feet of structures or buildings; granular materials meeting NYSDOT Item 304.12 in areas under and within 5 feet of pavements (asphalt, concrete or similar) and utility structures; and, Select Earth in all other areas. Backfilling shall be completed within one (1) week after start of work on the tree. Any open excavation as a result of this work, shall be properly protected to avoid harm to public, facility employees, work, equipment, or others.

3.6 FELLING OR PRUNING TREES

A. If it is impractical to fell trees as a whole, remove them in sections according to standard practices of professional tree removal. Fall trees to the center of the area being cleared to minimize damage to trees that are to be left standing.

B. Fall trees away from the slope embankments; stream banks, wetlands, swamps or other water courses; buildings; public or private roadways or sidewalks; and, trees/shrubs to remain.

C. Fall trees in a manner to minimize damage to existing pavements or structures.

D. Immediately after felling a tree, remove branches, cut trunk and limbs, and remove all materials from the site. All merchantable timber and wood, which is removed, shall become the property of the Contractor.

E. All trees to remain shall not come in contact with any machine or appliance that will in any manner injure, sear, or kill them.

F. All trees left standing, which have been trimmed or become scarred by Contractor's operations, shall be promptly repaired by properly cutting, smoothing, and painting.

G. Trees to be trimmed shall be evenly cut to achieve neat severance with the least possible damage to trees.

H. Prune branches that are affected by temporary and permanent construction. Prune branches as follows:
1. Prune trees to remain to compensate for root loss caused by damaging or cutting root system. Provide subsequent maintenance during Contract period as recommended by arborist.

2. Pruning Standards: Prune trees according to ANSI A300 (Part 1) and the following:
   a. Type of Pruning: Cleaning.
   b. Specialty Pruning: Restoration.

3. Cut branches with sharp pruning instruments; do not break or chop.

4. Do not apply pruning paint to wounds.

5. Chip removed branches and dispose of off-site.

I. Where roots are cut or damaged, apply wet burlap to prevent drying out.

3.7 TOPSOIL STRIPPING

A. Prior to any excavation or embankment or as directed by the Architect/Engineer, topsoil shall be removed. Topsoil work, such as stripping, stockpiling and similar work shall not be carried out when soil is wet so that tilth of soil will be destroyed.

B. Remove sod and grass before stripping topsoil.

C. Topsoil shall be stripped full depth in building areas, and all areas to be regraded, resurfaced or paved within the contract limit work area. Stripped topsoil shall be stockpiled in a location on site acceptable to the Owner’s Designated Representative or Architect/Engineer.

D. Strip topsoil in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, stones, and other objects more than 2 inches in diameter; trash, waste, branches, brush, debris, weeds, roots, and other waste materials.

E. Stockpile cleaned topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water. Provide and maintain erosion control measures around stockpiles including, but not limited to, silt fence.

1. Limit height of topsoil stockpiles to 72 inches.

2. Do not stockpile topsoil within protection zones.

F. Stockpiled topsoil will be used in finish grading for preparation of lawns and planting beds. No topsoil shall be removed from the site without the prior approval of the Architect/Engineer. All topsoil used in grading shall be screened to remove any materials larger than 2-inches in diameter.

G. Where trees are indicated to be left standing, stop topsoil stripping a sufficient distance to prevent damage to main root system.

H. If the Contractor fails to strip and stockpile all available topsoil within the limits of areas disturbed by his work, the Contractor shall at no cost to the Owner, import adequate topsoil to cover the disturbed areas to a minimum depth of 4-inches.
I. If topsoil does not exist, in sufficient quantity, on the site, the Contractor shall deliver, place and spread a sufficient quantity of acceptable topsoil necessary to achieve a depth of 6 inches over the entire area of the site indicated on the contract drawings to receive lawns and planting. Secure all topsoil from an approved source and submit a mechanical and chemical analysis to the Architect/Engineer for any topsoil, which is to be delivered.

3.8 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove all below-grade wood, organic material, and metal construction within demolition or removal area.

C. Remove slabs, paving, curbs, gutters, and aggregate base as indicated. Remove to the minimum extent possible to complete the work while utilizing existing joints.

1. Prior to full depth removal, saw cut asphalt and concrete paved surfaces. Use a saw, which will cut a neat, straight joint line along line of existing pavements to remain. 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. Carefully remove walks and curbs to the minimum extent possible. Store and protect for reuse if so designated.

D. All fences, signs, and other obstructions encountered shall be carefully taken-up and stored for subsequent replacement.

E. Do not disturb property markers unless absolutely necessary. If it becomes necessary to disturb or remove a property marker, have a licensed land surveyor provide four (4) ties to the marker. The licensed land surveyor shall replace the marker as soon as possible.

F. Remove and turn over to the Owner all items indicated to be salvaged.

G. Remove, store, protect, and reinstall all items indicated for relocation.

H. Remove and dispose off-site underground structures and piping indicated for removal on the Contract Drawings.

3.9 REGRADING AT OR ADJACENT TO PROTECTION ZONES

A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

B. Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist unless otherwise indicated.
1. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.

C. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

D. Minor Fill within Protection Zone: Where existing grade is 2 inches or less below elevation of finish grade, fill with topsoil. Place topsoil in a single uncompacted layer and hand grade to required finish elevations.

3.10 BACKFILLING

A. The Contractor shall be responsible for providing all necessary fill materials to backfill the resultant hole from removal of all plant materials.

B. Water in sufficient quantity may be required to assure compaction.

C. Earth and granular materials for backfill, shall be in accordance with Division 31 Section “Earth Moving”. Refer to Part 3 “Clearing and Grubbing” of this specification for additional information.

D. All excavations shall be backfilled to the original surface of the ground or as otherwise specified, or directed. Provide proper surface drainage and provide uniform levels and slopes. Backfilling shall be done with suitable excavated materials approved by the Architect/Engineer, and satisfactorily compacted.

E. The Architect/Engineer shall be the sole judge of what constitutes unsuitable material for backfill.

3.11 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 in accordance with requirements of all federal, state, local laws and ordinances off Owner's property. Remove cleared materials from the site as the work progresses.

B. Remove cleared materials from the site as the work progresses. All wood and brush shall be disposed of within 15 days after cutting or felling unless otherwise approved by the Architect/Engineer.

C. On site burning of combustible cleared materials is not permitted. On site burial of cleared materials is not permitted.

D. Leave site in a neat and orderly condition.

3.12 DUST & NOISE CONTROL

A. Complete dust and noise control in accordance with Division 31 Section “Earth Moving”.

SITE CLEARING
3.13 DEWATERING

A. Complete dewatering in accordance with Division 31 Section “Earth Moving”.

3.14 MAINTENANCE TRAFFIC

A. Complete maintenance and protection of traffic in accordance with Division 32 Section “Maintenance and Protection of Traffic”.

END OF SECTION 311000
SECTION 312000 - EARTH MOVING

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. Earth excavation.
   2. Cutting and filling of subgrade.
   3. Earthen embankments.
   4. Preparation of subgrade, including excavation and backfill, for buildings, structures, and foundations.
   5. Excavating and backfilling trenches for utilities and pits for buried utility structures.
   6. Preparing subgrades, including excavation and backfill, for slabs-on-grade, walks, pavements, turf and grasses, and plants.
   7. Excavation and removal of unsuitable bearing material.
   8. Soils and backfill materials consolidation and compaction.
   9. Grading outside building lines.
   10. Furnishing and placing earth and granular materials.
   11. Compaction and testing.
   12. Subsurface drainage backfill for walls and foundation/footing trenches.
   14. Removing from site excess and/or unsuitable fill.
   15. All other associated earthwork as necessary to perform the work under this Contract in conformance with the alignments, grades and detailed sections provided.

B. Related Sections:
   1. Division 03 Section “Cast-in-Place Concrete”
   2. Divisions 21, 22, 23, 26, 27, 28, and 33 Sections for installing underground facility utilities and buried utility structures.
   3. Division 31 Section “Site Clearing”
   4. Division 31 Section “Erosion and Sedimentation Control”
   5. Division 32 Section “Turf and Grasses”

C. Special Requirements
   1. Upon excavation, the subgrade shall be inspected by a qualified and independent testing representative obtained by the Owner. Subgrade shall be approved by the Owner’s representative before any new construction begins. Results of the tests must be reviewed and approved by the Architect/Engineer.
2. All excavation, fill or backfill placement, and utility construction shall be performed in the dry. The contractor shall be prepared to dewater as necessary. Subsurfaces shall be kept free of water, subjected to minimum amount of construction traffic, exposed no longer than necessary, and not permitted to freeze.

3. Site-Specific geotechnical information – See the Geotechnical Reports

1.3 DEFINITIONS

A. Backfill: Aggregate or earthen material material used to fill a-trench 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. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

C. Borrow Soil: Satisfactory soil imported from off-site (or on-site if permitted) for use as fill or backfill.

D. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

E. Embankment Foundation: Surface area upon which an embankment or fill is constructed.

F. Excavation: Removal of material encountered to subgrade elevations, lines, and dimensions required and the subsequent disposal of materials removed.
   1. Additional Excavation: When excavation has reached required subgrade elevations, notify the Owner’s Designated Representative, who will make an inspection of the conditions. If Architect/Engineer determines that bearing materials at required subgrade elevations are unsuitable, continue excavation until suitable bearing materials are encountered and replace excavated material as directed by Architect/Engineer.
   2. Unauthorized Excavation: Consists of removal of materials beyond required subgrade elevations or dimensions without specific direction of the Architect/Engineer or Owner’s Designated Representative. Unauthorized excavation, as well as remedial work directed by the Architect/Engineer or Owner’s Designated Representative, shall be at Contractor’s expense. Fill of unauthorized excavations shall be as follows:
      a. Under footings or foundation bases, fill of unauthorized excavations under footing or foundation bases shall be accomplished by extending lean concrete or well-graded crushed aggregate fill to bring elevations to proper position, when acceptable to Architect/Engineer.
      b. In locations other than those above, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by the Owner’s Designated Representative.
   3. Unclassified Excavation: Unclassified excavation shall consist of the excavation and disposal of all materials or obstructions, of any description, encountered during construction, unless otherwise specified.
G. Fill: Aggregate and/or earthen soil materials used to raise existing grades.

H. Loam: Soil mixture consisting of the following proportions:
   Sand 30 - 50%
   Silt 30 - 50%
   Clay 0 - 20%

I. Rock: Solid hard material located in ledges, bedded deposits and unstratified masses, and all natural conglomerate deposits so firmly cemented as to present all the characteristics of solid rock, which must be removed by blasting or pneumatic hammers. Rock does not include shale, slate, soft sandstone, hardpan, masonry or concrete rubble, boulders less than 2 cubic yards, such other rock material which is decomposed, stratified, weathered or shattered, or any material capable of being removed by a well maintained Caterpillar 225 power shovel, or equivalent.

J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, utility structures, pole bases, or other man-made stationary features constructed above or below the ground surface.

K. Subbase Course: Aggregate layer placed between the subgrade and asphalt pavement, concrete pavement, hardscape or stabilized topsoil area.

L. Subgrade or Subgrade Surface: Uppermost undisturbed surface of an excavation or the top surface of a compacted fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

M. Suitable Material: A material whose composition is satisfactory for use in embankment, backfill, or fill construction. Determinations of whether a specific material is suitable for a specific application shall be made by the Owner’s Designated Representative or Architect/Engineer.

N. Topsoil: Refer to Division 31 Section "Site Clearing".

O. Unstable Material: (if encountered) Unstable material shall mean debris and all wet, soft, or loose material, which does not provide sufficient bearing capacity to satisfactorily support pipes, structures or other work placed thereon.

P. Unsuitable Material: Unsuitable material shall mean excavated material, which in the opinion of the Owner’s Designated Representative or Architect/Engineer, does not meet specification requirements for backfilling, embankment, or filling purposes and includes unstable material.
   1. Unsuitable material shall fall into two specific categories. The first shall be that material which would be unsuitable under any circumstances including unstable materials. This category includes materials containing humus, spongy material, roots, stumps, muck, peat, and any other objectionable material. This material shall be disposed of in an approved off-site spoil area.
   2. The second category shall consist of material, which is unsatisfactory for backfill because of its moisture content at the time of excavation. This material shall be stockpiled in approved areas on the Project site. This stockpiled material, when satisfactory for backfill, as determined by the Architect/Engineer, shall be used in other areas lacking backfill.
3. Excavated materials, which become unsuitable as a direct result of the Contractor's work shall result in rejection of the unsuitable material by the Architect/Engineer.

4. The Owner’s Designated Representative or Architect/Engineer shall be the sole judge of what constitutes unsuitable material and into which category it falls.

Q. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

A. Product Data: For each type of the following manufactured products required:
   1. Geotextiles.
   2. Fill Material
   3. Warning tapes.

B. Material Test Reports: Contractor shall submit test results for laboratory gradation, moisture content (Proctor Tests), and maximum density tests certified by an approved testing laboratory or other requirements on the various imported soil and granular items, from each approved material source, prior to their use on the project:
   1. Classification according to ASTM D 2487.
   2. Laboratory compaction curve according to ASTM D 1557.

C. The minimum requirements for a prequalification submittal shall include a sieve analysis (ASTM D422) and standard proctor compaction (ASTM D698) of not more than 60 days old.

D. Provide material certifications for imported materials.

E. Submit list indicating locations where various soil earthen and granular materials will be utilized.

F. List of compaction plans of proposed compaction equipment and description.

G. Copies of measurements and computed volumes of unsuitable material removed shall be submitted to the Architect/Engineer.

H. Details of proposed sheeting, if required, shall be submitted by the Contractor to the Architect/Engineer for review and no sheeting shall be installed until written acceptance from the Architect/Engineer. Sheet design shall be stamped by NYS licensed professional engineer.

I. Submit Qualification Data: For qualified independent testing agency.

J. Pre-excavation 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.
1.5 QUALITY ASSURANCE

A. All finished grades shall be as shown on the Drawings or as specified by the Architect/Engineer. Contractor shall verify that survey benchmark and intended elevations for the work are as indicated. Contractor shall verify existing site conditions.

B. Contractor's independent testing agency shall be approved by the Architect/Engineer.

C. Erosion control measures in accordance with Division 31 Section “Erosion and Sediment Control”, the Project SWPPP and the NYSDEC SPDES General Permit for Stormwater Discharges from Construction Activity (GP-0-15-002) shall be followed.

D. When placing fill and backfill, all compaction and soil moisture requirements as delineated in this specification shall be followed. Lift thickness, and the compactive capabilities of the equipment used, shall be continually monitored by the Contractor to obtain the compaction efforts required.

E. Provide on-site at least one person who shall supervise the soil compaction operations, and who shall be thoroughly familiar with the various types of compaction equipment, proper compacting techniques and methods, and soils behavior, and who shall direct the compaction operations.

F. It is the responsibility of the Contractor to select, furnish and properly maintain equipment, which will compact the fill uniformly to the required density.

G. The Architect/Engineer will be the sole judge of the conformance of materials, workmanship, and compaction with the requirements of the Contract Documents.

H. Work referencing NYSDOT (New York State Department of Transportation) shall be in compliance with the New York State Department of Transportation Standard Specifications (NYSS) dated May 1, 2008 (and any subsequent revisions).

1.6 PROJECT CONDITIONS

A. When work is in public rights-of-way, the Contractor shall make necessary arrangement for permits, as required, at no extra cost to the Owner.

B. The Contractor shall be required to ascertain the complete extent of all permits required governing dewatering operations, and shall be bound by their conditions and provisions.

C. Provide and maintain emergency ingress/egress to the site at all times. Provide and maintain pedestrian and vehicle access to active facility, including but not limited to designated doors, sidewalks, and parking areas.

D. If trench widths and depths are exceeded, concrete cradles or other special installation procedures may be required and shall be provided where directed by Architect/Engineer. All additional costs, including the cost of redesigns, shall be borne by Contractor.

E. Moisten or dry backfill materials to the proper moisture content as determined in accordance with ASTM D1557, Method C in order to obtain proper compaction.
F. Utilities shown on the Contract Drawings are for the convenience of the Contractor, exact locations are not guaranteed. The Contractor shall verify existing utilities with the proper authorities.

G. Notify Dig Safely New York (UFPO) prior to commencing any excavation. Locate and identify existing underground and overhead services and utilities within contract limit work areas. Provide adequate means of protection of utilities and services, which are not designated to be removed. Repair utilities damaged during site work operations at Contractor’s expense.

H. The project site Owner is not a member of Dig Safely New York. The Contractor alone shall be responsible to locate all utilities and services outside the public rights-of-way. The Contractor shall complete test pits as needed to confirm underground utilities and services. The cost of all test pits shall be included in the price bid. Provide adequate means of protection of utilities and services, which are not designated to be removed. Repair utilities damaged during site work operations at Contractor’s expense.

I. Minimize interference with adjoining roads, streets, walks, parking areas and other adjacent occupied or used facilities during earth moving operations. Refer to Division 32 Section “Maintenance and Protection of Traffic” for traffic maintenance information.

J. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
   1. Do not proceed with work on adjoining property until directed by Owner’s Designated Representative.

K. Locate, protect, and maintain benchmarks, monuments, control points, and project engineering reference points. Reestablish disturbed or destroyed items at Contractor’s expense.

L. The control of dust, noise, erosion, and sediment originating from construction operations is considered a critical responsibility of the Contractor. The Construction Manager will be the final judge of the adequacy of the Contractor’s dust, noise, erosion, and sedimentation control. Work may be suspended by the Construction Manager until adequate dust, noise, erosion, and sedimentation control is attained.

M. Protect structures, utilities, sidewalks, pavements, buildings, and other services or facilities on site and adjacent to the site from damage caused by earth moving operations or other work in support of Contractor operations. Cost of repair and restoration of damaged items shall be at Contractor’s expense.

N. The Contractor shall take precautions to protect from harm the work of other contractors on site, existing facilities, as well as adjacent property. The Contractor shall be responsible for all damage or injury done to pipes, structures, utilities, pavement, buildings, property or person as a result of work performed to complete this contract. The Contractor at his own expense shall repair or replace such property or item to the satisfaction of the property owner, utility owner, public agency having jurisdiction, Architect/Engineer and Construction Manager.

O. When it is necessary to haul materials over the streets or pavements, the Contractor shall provide suitable tight vehicles so as to prevent deposits on the streets or pavements. In all cases, where any materials are dropped from the vehicles, the Contractor shall clean up the same as often as
directed and keep the crosswalks, streets, pavements and drainage ways clean and free from dirt, mud, stone, and other hauled materials.

P. Contractor shall be responsible for cleaning private and public; roads, parking areas or walkways, of any material carried onto these roads or pavements by trucks or other equipment completing work in support of this project. Associated costs shall be included in price bid.

Q. The following practices are prohibited within tree- and/or plant-protection zones:
   1. Storage of or stockpiling of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Foot traffic.
   4. Erection of sheds or structures.
   5. Impoundment of water.
   6. Excavation or other digging unless otherwise indicated.
   7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
   8. Do not direct vehicle or equipment exhaust towards protection zones.
   9. Prohibit heat sources, flames, and ignition sources within or near protection zones.
  10. Do not store materials potentially harmful to tree roots. Potentially harmful materials include, but are not limited to petroleum products, cement, lime, paints, detergents, acids and cleaning agents.

R. The Owner and Architect/Engineer do not guarantee that all required excavation can be executed by use of machinery. In some cases, it may be necessary to revise proposed alignments, which may preclude the use of machinery. In this event, the Contractor shall be required to perform this work by any method at the same price(s) bid in the Proposal, with no additional compensation due to the inability to use machinery.

S. The existing ground elevations as shown on the Drawings are believed to be reasonably correct. The Contractor shall satisfy himself, however, by actual examination of the sites of the work, as to the existing elevations and the amount of work required under this section. No claim shall be made by the Contractor for additional compensation for conditions other than that shown.

T. The Contractor shall remove any waste material or other debris that has accumulated as a result of the work of this section and dispose in conformance with applicable legal requirements and in a manner acceptable to the Construction Manager or Architect/Engineer.

U. Soil reports and boring logs: Refer to Division 01: Geotechnical Reports.

1.7 TRIAL EXCAVATIONS

A. After the Contract is awarded, and prior to fabrication of steel and other framing members, the Contractor shall perform trial excavations, as directed by the Architect/Engineer, to verify certain existing conditions which may affect the proper dimensioning and fit of steel or other framing members.

B. Contractor shall construct test pit excavations to determine the locations of underground utilities or structures as shown on the plans and/or as ordered by the Construction Manager or
Architect/Engineer. Underground utilities and/or structures shall be located and tied off for future stake out. The test pit shall be properly backfilled and compacted. Surface restoration shall be performed as required and as ordered by the Construction Manager or Architect/Engineer.

1.8 STORAGE AND HANDLING

A. Stockpiling of earth spoil or excess earth material on the site or storage of excavated materials for reuse shall be done in a manner which will not hinder the progress of the work; cause any nuisance; or cause spillage or tracking of materials from the transporting vehicle onto public or private roadways, parking areas, sidewalks or pavements, or cause an inconvenience to adjacent property owners or tenants, general public, other contractors, or facility operations.

B. Obstruction of roads, driveways, parking areas, sidewalks, or interference with drainage along curbs, gutters, ditches, or drainage channels with stored material is not permitted.

C. On-site topsoil suitable for final placement and grading shall be excavated and stockpiled on-site for future use in accordance with Division 31 Section “Site Clearing”. Imported topsoil shall be stockpiled on-site in a separate location from on-site topsoil. Each stockpile shall be well-shaped and graded in order to shed water and to avoid contamination by other granular or earth materials temporarily stockpiled on-site. Provide and maintain erosion control (silt fence) around stockpiles.

1.9 SCHEDULING

A. If required to complete the work properly, the Contractor shall obtain grading releases from property owners near trenching or other grading operations at least ten (10) days before commencement of the work.

B. Do not commence site earth moving operations until temporary erosion- and sedimentation-control and tree- and plant-protection measures are in place.

C. Allow time to rework, screen and moisture condition on-site and/or imported soils for placement.

D. Except by permission of the Architect/Engineer, not more than 200 feet of trench shall be opened at any one time. Not more than 100 feet of trench may be opened in advance of the completed pipe laying operations; and not more than one street crossing may be obstructed by the same trench at any one time.

E. Schedule the work to allow ample time for laboratory tests and to permit the collecting of samples and the performing of field density tests during the backfilling and compaction operations.

F. All subgrades shall be approved by Architect/Engineer or Construction Manager before pipes, structures, and facilities are installed or concrete is placed. Results of the tests must be reviewed and approved by the Architect/Engineer.

G. Do not backfill against concrete elements until bearing surfaces have reached design strength or are properly braced and backfilling operations are approved.

H. Compaction shall not take place in freezing weather or when materials to be compacted are frozen, too wet or moist, or too dry.
PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. **Common Earth:** (for use under nonpaved areas located at least 5-feet outside building/structure limits only) - Sand, loam, gravel, or similar materials free from debris, frozen materials, organic materials, or other deleterious material, and containing some rock fragments, stones, and pebbles, not exceeding 4 inches in their largest dimension and meeting the following requirements:

1. Plasticity index of not more than 30 - ASTM D424.
2. Minimum laboratory dry weight at optimum moisture content of 110 pounds per cubic foot.

Provide imported Common Earth fill materials as required to complete the work. Contractor shall obtain rights and pay all cost for imported materials.

Proposed Common Earth fill (imported or site excavated) material shall be inspected, tested, and laboratory report issued prior to use in the work.

B. **Select Earth:** Sand, gravel, and similar material which shall be free from silt, clay, loam, organic material, roots, debris, waste, frozen material, or other deleterious materials, and shall only contain small amounts (less than 10 percent) of stone, pebbles, or lumps over one inch in greatest dimension, but none over 2 inches in greatest dimension.

Imported select earth materials shall meet requirements of the NYSDOT Standard Specification Section 203-2.02C except that no material shall exceed 2-inches in their largest dimension.

C. **Imported Topsoil:** Imported topsoil shall meet the requirements of NYSDOT Specification Section 713-01, except provide 6 percent minimum organic material. The Contractor shall be responsible for amending imported topsoil with approved materials and by approved methods to meet these requirements and in accordance with Division 32, Section “Turf and Grasses” and Section “Athletic Field Preparation”, at no additional cost to the Owner. The material shall be stockpiled, tested and approved by Owner’s Designated Representative prior to use on the project. Obtain topsoil from naturally well-drained sites where topsoil occurs at least 4-inches deep; do not obtain from bogs or marshes.

D. Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

E. Acceptance of all types of soil materials shall be based on the above requirements, and the Owner’s Designated Representative or Architect/Engineer shall make final acceptance. Such acceptance or rejection of materials is binding upon the Contractor.

2.2 GRANULAR MATERIALS

A. **Cushion Sand:** The material shall meet the requirements of NYSDOT Standard Specification Section 703-06, Cushion Sand.

B. **Bedding Sand:** Sand shall consist of clean, hard, durable, uncoated particles, free from lumps of clay and all deleterious substances. When dry, the sand shall meet the following gradation requirements:
C. **Crushed Stone:** Material shall be clean, sound, crushed stone of uniform quality. It shall be a 50-50 mixture of NYSDOT primary size designation #1 and #2 stone as per NYSDOT Standard Specifications, Section 703-02, Material Designation 703-0201. Mixture shall meet the following gradation requirements:

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<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
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<tbody>
<tr>
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<td>100</td>
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<tr>
<td>1 inch</td>
<td>95-100</td>
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<tr>
<td>½ inch</td>
<td>45-57.5</td>
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<tr>
<td>1/4 inch</td>
<td>0 - 7.5</td>
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D. **Subbase Material:** Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand. NYSDOT Standard Specification, Section 304, Type 2 or Type 4, corresponding to Items 304.12 or 304.14 respectively. Gradation requirements:

```
<table>
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<tr>
<th>Sieve Designation</th>
<th>Percent by Dry Weight Passing Square Mesh Sieves Type 2</th>
<th>Percent by Dry Weight Passing Square Mesh Sieves Type 4</th>
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<tr>
<td>2 inch</td>
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<td>100</td>
</tr>
<tr>
<td>1/4-inch</td>
<td>25 to 60</td>
<td>30 to 65</td>
</tr>
<tr>
<td>#40</td>
<td>5 to 40</td>
<td>5 to 40</td>
</tr>
<tr>
<td>#200</td>
<td>0 to 10</td>
<td>0 to 10</td>
</tr>
</tbody>
</table>
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E. **Structural Fill:** Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand. NYSDOT Standard Specification, Section 304, Type 2 or Type 4, corresponding to Items 304.12 or 304.14 respectively. Gradation requirements:

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<table>
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<tr>
<th>Sieve Designation</th>
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<th>Percent by Dry Weight Passing Square Mesh Sieves Type 4</th>
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<td>25 to 60</td>
<td>30 to 65</td>
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<tr>
<td>#40</td>
<td>5 to 40</td>
<td>5 to 40</td>
</tr>
<tr>
<td>#200</td>
<td>0 to 10</td>
<td>0 to 10</td>
</tr>
</tbody>
</table>
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F. **Underdrain Filter Material:** Shall meet the requirements of NYSDOT Standard Specification Section 605-2.02, Type II Underdrain Filter Material.
G. **Underdrain Sand Filter Material**: (Use with Type 1 Corrugated HDPE Underdrain only) Shall be coarse and medium sand meeting the following size range:

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<td>97-100%</td>
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<tr>
<td>#18</td>
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<tr>
<td>#60</td>
<td>0-20%</td>
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<tr>
<td>#100</td>
<td>0-3%</td>
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</table>

H. **Pea Gravel**: Shall be screened, washed gravel meeting the graduation requirements of NYSDOT primary size designation #1A stone as per NYSDOT Standard Specifications, Section 703-02.

I. **Light and Medium Stone Fill**: The material shall meet the requirements of NYSDOT Standard Specification Section 620-2.02 for light and medium stone fill.

J. Acceptance of all types of fill shall be based on the above requirements, and the approval of the Architect/Engineer or Geotechnical Engineer. Such acceptance or rejection of materials is binding upon the Contractor.

2.3 **GEOTEXTILES**

A. **Pavement Stabilization Geotextile Fabric**: The geotextile fabric for pavement stabilization shall be Mirafi 500X as manufactured by Mirafi, AMOCO 2002, Synthetic Industries 200ST or approved equal. The geotextile fabric shall be woven fabric of only continuous chain polymeric filaments or yarns of polyester. The fabric shall be inert to commonly encountered chemicals, hydrocarbons, mildew, and rot resistant. The fabric shall be UV stabilized.

<table>
<thead>
<tr>
<th>Acceptable Fabric Properties – Mirafi 500X</th>
<th>Value</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grab Tensile Strength, kN (lbs)</td>
<td>0.9 (200)</td>
<td>ASTM D4632</td>
</tr>
<tr>
<td>Elongation at Failure, % MD/CD</td>
<td>15/ 15</td>
<td>ASTM D4632</td>
</tr>
<tr>
<td>Mullen Burst Strength, kPa (psi)</td>
<td>2756 (400)</td>
<td>ASTM D3786</td>
</tr>
<tr>
<td>Trapezoidal Tear Strength, kN (lbs)</td>
<td>0.33 (75)</td>
<td>ASTM D4533</td>
</tr>
<tr>
<td>Puncture Strength, kN (lbs)</td>
<td>0.40 (90)</td>
<td>ASTM D4833</td>
</tr>
<tr>
<td>Apparent Opening Size (AOS)</td>
<td>40</td>
<td>US Std. Sieve</td>
</tr>
<tr>
<td>Permittivity, sec⁻¹</td>
<td>0.05</td>
<td>ASTM D4491</td>
</tr>
<tr>
<td>Flow Rate, l/min/m² (gal/min/sf)</td>
<td>163 (4.0)</td>
<td>ASTM D4491</td>
</tr>
<tr>
<td>UV Resistance after 500 hrs, % strength</td>
<td>70</td>
<td>ASTM D4355</td>
</tr>
</tbody>
</table>

B. **Soil Separator Fabric**: The nonwoven geotextile fabric, composed of polypropylene fibers to be used at drainage applications, shall be Mirafi 140n as manufactured by Mirafi or approved equal.

C. **Geogrid**: The geogrid shall be manufactured from a punched polypropylene sheet oriented in equilateral triaxial directions, such as Mirafi TG-7 as manufactured by Tensar, or approved equal.
2.4 ACCESSORIES

A. **Warning Tape:** Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility in bold readable lettering; colored as follows:

2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.

B. **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 in bold readable lettering, 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: (Detectable warning tape shall be a minimum of 12-inches wide for utilities where Drawings indicate tape shall be buried greater than 30-inches.)

2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

C. **Tracer Wire:** Wire shall be 10 AWG stainless steel tracer wire. The wire shall be extended into tracer wire boxes with adequate excess wire to extend 2 feet above grade.

D. **Tracer Wire Boxes:** Tracer wire boxes in lawn areas shall be 4-inch shaft cathodic protection test boxes Model P445 DT Test as manufactured by Bingham & Taylor or approved equal. Provide cast iron rim and pentagon nut lid. Lid shall be blank with no lettering. Body of box shall be ABS plastic.

1. Box shall be 3-foot in length with standard base.
2. Provide each box with a terminal block containing four terminals.
3. The box shall not transmit shock or stress to the tracer wires and shall be plumb with the box cover flush with the surface of the finished grade.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain erosion and sedimentation controls during earth moving operations.

B. Before placing subsequent materials remove temporary protection installed to protect subgrades and foundation soils from freezing temperatures and frost.

C. Prior to start of work, the Contractor's surveyor shall verify that all boundaries of temporary and permanent easements and property lines are clearly marked in the field so that the work will not violate these boundaries.
D. The Contractor and his surveyor shall verify the locations and character of structures, underground lines, and subsurface conditions and verify that the described work will not adversely affect them.

E. The Contractor's Surveyor shall verify that grade stakes have been properly and accurately set.

F. The Contractor shall be responsible for providing all necessary fill materials.

3.2 METHODS OF CONTROL FOR EXCAVATIONS AND GRADING

A. The Contractor shall employ at the site a NYS licensed surveyor responsible for the proper layout of utilities, structures, and drainage. He shall maintain adequate stakeout control for inspection of the work and to accurately complete construction.

B. The alignment and depth of subgrades of all pipe trenches shall be determined by overhead grade lines or laser at Contractor's option, installed and maintained by his surveyor.

C. In the event that rock is encountered, the Contractor will take cross sections of the rock uncovered. No removal shall begin until adequate time has been given the Owner’s Designated Representative or Architect/Engineer for inspection and to verify the measurement of rock material.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 EARTH MOVING, GENERAL

A. The work shall be performed by methods acceptable to the Owner’s Designated Representative or Architect/Engineer.

B. Excavation shall include the satisfactory removal and disposal of all materials encountered, regardless of the nature of the materials, or the manner in which they were excavated, except materials classified as rock excavation.

C. Excavate to subgrade elevations. Do not excavate rock until it has been classified and cross sectioned.

D. All pipe lines or existing structures encountered during the excavation operation and designated to remain shall be properly supported/protected to prevent damage.

E. Erosion and sedimentation control measures meeting the requirements of Division 31 Section “Erosion and Sediment Control” shall be used around all earthen material stockpiles.

F. Provide and maintain adequate temporary crossovers for pedestrian and vehicular traffic, including temporary gravel drives, steel plates, guardrails, lamps, flags; remove same when necessity for such protection ceases. All traffic maintenance shall be done in a manner satisfactory to the Owner’s Designated Representative or Architect/Engineer.
G. Provide and maintain suitable temporary crossings over open trenches where necessary to maintain access for other Contractors, the Architect/Engineer or general public (if applicable).

H. The Contractor shall have available a supply of steel plates with minimum dimensions of 4 feet x 8 feet x 1 inch, or thicker, as required by jurisdictional authorities and to maintain emergency access and egress to the site. The plates shall be used to bridge open trenches crossing roadways, or driveways as directed by the Architect/Engineer. When used, they shall be secured against the possibility of shifting or dropping into the excavation. During winter months, these plates shall not be left in the roadway or driveway overnight unless specifically required by the Architect/Engineer.

I. When excavating in or adjacent to the traveled portion of highways, driveways, or parking areas take whatever measures are necessary to protect the road/drive/parking surfaces from becoming undermined.

J. Protect trees indicated to remain in accordance with Division 31 Section “Site Clearing”.

K. All traffic maintenance shall be done in a manner satisfactory to the Architect/Engineer.

3.5 SOIL STABILIZATION

A. Sloped sides of excavations shall comply with local codes, ordinances, and requirements of agencies having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling and/or filling.

B. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces, etc. in good serviceable condition. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Extend shoring and bracing as excavation progresses.

C. Daily inspections of excavations shall be made by an authorized competent representative of the Contractor performing the excavation work.

3.6 DRAINAGE/DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

1. Surface and ground water shall be intercepted and removed before entering excavations. All necessary measures shall be taken. Earth dikes, ditches or other devices, if required, shall be constructed to prevent such flows.

B. 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.
2. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations.

3. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

C. The Contractor shall at all times provide and maintain proper and satisfactory means and devices (i.e. ditches, temporary pipes, pumps, and/or other temporary construction) for the removal of all water entering the excavations. Water shall be removed as fast as it may collect, in such manner that shall not interfere with the execution of the work or in the proper placing of pipe, structures or other work.

D. The Contractor shall make his own determination as to required dewatering operations necessary to complete the work. Contractor shall have available at all times sufficient equipment, machinery, piping, and appurtenances for pumping water to keep excavations free from water during construction.

E. Where the presence of fine grained subsurface materials and high groundwater table may cause the upward flow of water into the excavation with a resulting quick or unstable condition, the Contractor shall install and operate a well point system to prevent the upward flow of water during construction.

F. All water removed from the trenches or excavations by pumping, bailing, siphoning, well-points, or other means shall be disposed of in such a manner so as to avoid damage to the work, work of other Contractors, surface and ground water, persons or property. Unless otherwise permitted by the Architect/Engineer, groundwater encountered within the limits of excavation shall be depressed to an elevation not less than 12 inches below the bottom thereof before pipe laying, concreting or masonry is started, and shall be so maintained until concrete and joint material have attained adequate strength.

G. The Contractor shall not discharge water from dewatering operations directly into any line or intermittent stream, channel, wetlands or surface water. The Contractor shall not discharge water from dewatering operations directly into the storm or sanitary sewer system without prior approval of the Architect/Engineer. If the quality of the trench water is not better than or equal to that of the receiving stream, the Contractor shall perform all work necessary to improve the quality of the removed water in accordance with all requirements of the agencies having jurisdiction. This work shall include, but not be limited to, filtration, settling, and screenings meeting the requirements of the New York State Standards and Specifications for Erosion and Sediment Control to reduce the amount of sediment contained in the water to allowable levels, as acceptable to the Architect/Engineer, prior to disposal.

H. All costs to ensure proper drainage, dewatering and discharge from dewatering operations shall be at the Contractor’s expense.

I. The Contractor shall be responsible for repairing, at his own expense, any ruts, gullies, sloughage, slides, and cleaning or repairing any catch basins or storm drainage lines which display signs of silt build-up during the course of construction until the contract is complete.

J. Provide adequate protection from the effects of possible uplift due to storm or groundwater where buoyancy might lift installed work or cause joint or structure failure during construction.
K. Protect the interior of installed work from the entering and accumulation of liquids, ice, and snow. Immediately remove and dispose any accumulation, which may occur.

L. Adjust, repair, replace, or clean all work, surfaces, and property, which may have been damaged as a result of any dewatering operation.

3.7 SOIL CONDITIONING

A. Provide all wetting, drying, mixing and screening equipment and materials necessary to condition on-site soils to optimum moisture for compaction and required gradation.

B. Allow time to rework, screen and moisture condition on-site soils for placement.

C. Moisture Control: Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 3 percent of optimum moisture content. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   1. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations.

D. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 3 percent and is too wet to permit compaction to specified density.

E. Stockpile or spread soil material that has been removed because it is too wet to permit compaction. Assist drying by discing, harrowing, or pulverizing until moisture content is reduced to a satisfactory value.

3.8 MANNER OF EXECUTION

A. Materials for reuse on the project shall be stockpiled in an approved designated area adjacent to the work site. Suitable excavated material to be used for trench backfill or earthen fill shall be properly segregated by the Contractor to avoid mixture with topsoil or other unsuitable materials. Contamination of the excavated material as a direct result of the Contractor’s work shall result in rejection of the contaminated material by the Owner’s Designated Representative or Architect/Engineer.

B. The excavated material to be used for trench backfill or earthen fill shall be stored so that it will cause a minimum of inconvenience to public travel, active facility, adjacent owners or tenants and other contractors or subcontractors. Excavated material shall not be stored in the roadway, parking areas or sidewalks at any time.

C. Conduct operations in a manner, which will keep the work free of standing and flowing water and dispose the water so as not to damage or create a nuisance to the work, the public, surface, groundwater, and adjacent properties.

D. The accumulation of liquids, ice and snow in excavation, trenches, areas to be graded, and adjacent areas during construction is not permitted.
E. Keep graded surfaces well drained, but avoid erosion. Do not place earth or granular fill on wet grade, in water, or over frost, ice or snow. Excavations shall be maintained free of water.

F. Pipe trenching, building foundations, and structural undercuts: Under normal conditions, the excavation shall be vertical open cut from the ground surface. Tunneling beneath trees and certain surface structures may be required.

G. Bottom of excavations shall be finish graded by hand methods to receive bedding. The stone bedding shall be placed, compacted, and trimmed by hand to ensure the grade as necessary or as detailed.

H. Trench sheeting and bracing shall be placed as required to meet local, state and federal safety regulations.

I. The Architect/Engineer reserves the right to order sheathing and bracing to be left in place where removal may create damage or impair integrity of the work. The right of the Architect/Engineer to order sheathing and bracing to be left in place shall not be construed as creating any obligation on his part to issue such orders. His failure to exercise his right to do so shall not relieve the Contractor of any liability for damages to persons or property occurring from or upon the work of constructing the sewer, water main, or appurtenances occasioned by negligence or otherwise, growing out of a failure on the part of the Contractor to leave in place the trench sufficient sheathing and bracing to prevent the caving or moving of the ground, or disturbance of the completed work or any of the subsurface structures.

J. As required, the Contractor may add sufficient water during compaction to assure a complete consolidation of the material. This work shall be at no additional cost to the Owner. Where, in the opinion of the Owner’s Designated Representative or Architect/Engineer, adequate consolidation is not being obtained, additional density tests may be ordered at the expense of the Contractor.

K. The Contractor shall make up any settlement of trenches or embankments with suitable material and stabilize at no additional cost to the Owner. This work shall be performed promptly and as directed by the Owner’s Designated Representative

3.9 GRADING

A. General: Excavate, transport, place, compact and uniformly grade areas within the project limit (including excavated and filled sections and adjacent transition 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.
   3. The degree of finish shall be that is ordinarily obtainable from either a blade, grader or scraper operations.
   4. Subgrade surfaces shall drain, be compacted, and well graded.

B. Temporary Ditches, Swales: Install temporary or permanent diversion ditches and/or temporary pumps and take other steps as may be required to effectively eliminate potential water damage in
accordance with the Division 31 Section “Erosion and Sediment Control” or instructions received from the Architect/Engineer.

C. The Contractor shall be responsible to subtract from finished grades shown on the plans the depths indicated on the Contract Drawings to ensure that the proper subgrade elevations are established. Any questions regarding subgrade elevations shall be answered by the Architect/Engineer. The Architect/Engineer's decision shall mandate.

D. Site Rough Grading:

1. Unauthorized Excavation: Do not perform excavation work for any purposes other than those indicated on the Contract Drawings, unless so directed by the Architect/Engineer.

2. Slope grades to direct water away from buildings and to prevent ponding.

3. Finish subgrades to required elevations within the following tolerances:
   a. Turf, Planted Areas or Unpaved Areas: Plus or minus 1 inch.
   b. Walks: Plus or minus 1 inch.
   c. Pavements and slabs: Plus or minus 1/2 inch.

E. Grading under and within 10 feet of Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

F. Slopes: All swales shall be finished to drain readily. Unless otherwise indicated on the Contract Drawings, the surface of the subgrade in areas to receive lawns shall have a minimum slope of 2% unless otherwise agreed upon by the Architect/Engineer. All areas shall have positive drainage. Round tops and bottoms of all slopes and drainage swales. Adjust slopes at intersections of cuts and fills and warp to flow into each other or into the natural ground surface without noticeable break. Establish earth at tops and bottoms of rock ledges in accordance with instructions received from the Architect/Engineers and in a manner that will prevent erosion.

G. Following stripping, the subgrade shall be compacted sufficiently to develop required compaction to a depth of at least 12 inches. Within building, pavement and retaining wall limits, no fill shall be placed until the subgrade has been proofrolled and approved by the Architect/Engineer. If subgrade ruts, waves or quakes during proofrolling, recompact or replace the unacceptable areas and proofroll again. Repeat process until satisfactory results are obtained as approved by the Architect/Engineer.

H. The Contractor shall dispose of excess excavated material in accordance with Part 3-Disposal.

3.10 EXCAVATIONS BELOW SUBGRADE

A. In case earth materials encountered at subgrades are unsuitable, the Contractor shall immediately notify the Architect/Engineer and shall excavate from the limiting subgrades shown or specified, to such new lines and grades, as will be ordered. Excavation below subgrade shall be done only upon express orders of the Owner’s Designated Representative or Architect/Engineer.

B. At subgrade in pavement areas any loose, soft, wet, frozen, organic, or otherwise unsuitable material shall be removed.

C. Whenever excavations are carried beyond or below the lines and grade shown on the Plans, or as given or directed by the Owner’s Designated Representative or Architect/Engineer, all such over-
excavation shall be backfilled with special backfill such as: engineered fill; concrete or other materials as directed by the Owner’s Designated Representative or Architect/Engineer.

1. Fill over-excavations under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Whether over-excavation was directed by the Owner’s Designated Representative or Architect/Engineer or unauthorized, backfill shall match the concrete strength of the foundation to be installed.

2. Fill authorized or unauthorized over-excavations below other construction, pipe, or conduit as directed by Owner’s Designated Representative.

3. In pavement areas fill over-excavations with Structural Fill.

D. Special backfill materials ordered by the Architect/Engineer as a result of unauthorized over-excavation by the Contractor without prior approval shall be provided by the Contractor at no additional cost to the Owner.

E. Payment for authorized over-excavation and subsequent backfill materials shall be on a unit price basis agreed between the Owner and the Contractor prior to the required work.

F. All material which slides, fails, or caves into the established limits of excavations due to any cause whatsoever, shall be removed and disposed of at the Contractor's own expense and no extra compensation shall be paid the Contractor for any materials ordered for backfilling the void areas left by the slide, fall, or cave-in. It is the Contractor's responsibility to make all excavations safe for ongoing construction.

3.11 UNSTABLE SOILS REMOVAL METHODS (if required)

A. Methods of Removal: Prior to the start of excavation operations, divert water away from work area and create dry conditions. Through the use of dragline, clamshell, or other necessary equipment, excavate and legally dispose of all unacceptable material.

B. Precautionary Measures: Divert the run-off of mud and water during the course of removal of wet and unstable material to avoid adversely effecting adjacent construction or site improvement operations. Barricade, rope off, or otherwise protect workmen, active facility, and the public from open excavations, waterholes, and other hazards resulting from the work of this operation.

C. Damage: The Contractor shall correct any damage to structures, foundations, site improvement work or adjacent property resulting from the work of this operation.

D. Degree of Removal Required: Remove all unstable material to the point of sound stable earth or as directed by the Architect/Engineer.

3.12 ROCK EXCAVATION (if required)

A. Degree of Removal required: Rock, if encountered shall be removed to depths (pay lines) as follows:

1. In Building Areas
   a. 2-foot outside of concrete work for which forms are required, except footings.
   b. 1-foot outside perimeter or concrete forms of footings.
c. Under slabs on grade: to subgrade or 8-inches below bottom of concrete slab whichever is greater.

2. Under Areas to Receive Pavement - To the surface of the respective subgrade for such areas. Boulders or isolated pockets of rock shall be removed to 12-inches below the pavement subgrade and the resultant excavation backfilled with pavement subbase-course material.

3. Under Lawn and Planted Areas - To 24-inches below finished grade. Boulders or protruding rock outcropping where in the manner determined by the Architect/Engineer may be left undisturbed, provided a directive to this effect is transmitted to the Contractor.

4. In pipe trenches for pipes 18-inch diameter and smaller: 6-inches below bottom of pipe and 2-feet wider than outside diameter of pipe, one (1) foot each side of pipe, but not less than 3-foot minimum trench width.

5. In pipe trenches for pipes larger than 18-inch diameter refer to Contract Drawing details for additional rock removal requirements.

6. In all other cases to 6-inches below subgrade.

7. No payments will be made for excavation beyond pay lines.

B. No blasting is allowed.

C. The Contractor is responsible for measurement of rock material in place. (Also refer to Part 3 – Methods of Control of Excavation and Grading.)

D. Payment for rock removal shall be on a unit price basis agreed between the Owner and the Contractor prior to rock removal.

3.13 EXCAVATION FOR STRUCTURES

A. Excavations for structures and facilities shall be of sufficient size to give suitable room for proper construction procedures and no larger, or as shown on the Contract Drawings.

B. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services, backfilling and compaction work and other construction, and for inspections. Provide clearance sufficient for formwork. Banks and sides shall be at angle of repose of recline or sheathed, sheeted, shored and braced as required for safety, and conforming to all applicable laws, rules, regulations and codes. Remove shoring prior to backfilling, unless otherwise directed by the Architect/Engineer.

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 and remove loose materials and debris from excavation so that all footings rest on solid rock or approved undisturbed bearing soil, to leave solid base to receive other work.

2. If unsuitable bearing soil is encountered at depth indicated on Contract Drawings for foundation, the Contractor shall notify the Architect/Engineer and shall not proceed further until direction is given.
3. 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.

C. Ensure that movement of equipment in excavation does not cause working or pumping of underlying soil, which is not to be excavated. Should equipment cause the soil to work or pump, use other methods of excavation to maintain the design bearing capacity of the soil.

3.14 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.15 EXCAVATION FOR UTILITY TRENCHES

A. General

1. Trenches shall be excavated as shown on the Contract Drawings.

2. Before any trenching operation starts, the line of work shall be cleared and all existing underground pipe lines and structures located. Test pits shall be opened where necessary to properly establish the location.

3. When trenches crossing other pipe lines occur, machine excavation shall stop at least 2 feet away from the location of any pipe. The pipe line shall than be uncovered by manual excavation before proceeding with machine work.

4. Trenches shall be kept free of water by pumping or providing well points.

5. Trench sheeting and bracing shall be placed as required to meet local, state and federal safety regulations.

6. All pipe lines encountered during the trenching operation shall be properly supported to prevent damage.

B. Excavate trenches to indicated gradients, lines, depths, and elevations.

C. 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.

D. Utility Trench to be excavated and backfill to the extents described in the geotechnical report.

E. Trench Bottoms: (Where bedding course is not required.) Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference.
3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
4. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course. Refer to Part 3 – Rock Excavation

F. **Trench Bottoms**: (Where bedding course is required [e.g. facility water main, storm and sanitary sewers; and, pipes or conduits constructed under footings or foundations)
   1. For pipes and conduits 18-inches or smaller in nominal diameter, excavate trenches minimum of 6-inches deeper, than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
   2. For pipes 21- to 36-inches in nominal diameter excavate trenches minimum of 9-inches deeper, than bottom of pipe and conduit elevations to allow for bedding course.
   3. Excavate trenches in rock or other unyielding bearing material to depths indicated above depending on pipe or conduit size to allow for bedding course. Refer to Part 3 – Rock Excavation.

3.16 **PROOF-ROLLING AND SUBGRADE INSPECTION**

A. After all existing vegetation, paving, and topsoil are removed from the building footprint (and 5 feet beyond), and prior to foundation excavation, the exposed grade is to be proof-rolled, on a day free of rain, with a five-ton smooth drum roller, operating in its vibratory mode, performing five overlapping passes at walking speed.
   1. The owner's geotechnical engineer is to observe this operation and direct the contractor to remove soft areas of soil as required.
   2. Do not proof-roll wet or saturated subgrades.
   3. Excavate soft spots, unsuitable soils, and areas of excessive pumping or rutting, as identified by Geotechnical Engineer and as directed by Owner, and replace with compacted backfill or fill as directed. Notify Architect in writing of any required remediation.
   4. Install slab subbase immediately following satisfactory proof-rolling.

B. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices (if applicable) or changes in the Work.

C. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities without additional compensation.

D. Notify Owner’s Designated Representative when excavations have reached required subgrade.

3.17 **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. All stockpiled materials shall be stored in locations so as not to endanger the work, and so that easy access may be had at all times to all parts of the excavation. Stored materials shall be kept neatly...
piled and trimmed, so as to cause as little inconvenience as possible to other Contractors on site, to adjoining property owners and to the active facility.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

B. Topsoil suitable for final grading shall be removed and stored on-site separately from other excavated material.

C. Place, grade and shape stockpiles for proper drainage. Provide proper erosion control measures around stockpiles.

3.18 BACKFILL

A. All excavations shall be backfilled to the original surface of the ground or to the lines and grades as shown on the Contract Drawings or as otherwise specified, or directed. Backfilling shall be done with suitable excavated materials as shown on the Contract Drawings or approved by the Architect/Engineer, and satisfactorily compacted.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

C. Place and compact backfill in excavations promptly, as work permits but not before completing the following:
   1. Acceptance of construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
   2. Inspection, testing, approval, and recording of locations and inverts for underground utilities has been performed and documented.
   4. Removal of temporary shoring and bracing, and sheeting and backfilling of voids with satisfactory materials.
   5. Removal of trash and debris from excavation.
   6. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

D. Excavated material considered by the Owner’s Designated Representative or Architect/Engineer to be unsuitable for backfilling shall not be used, and shall be disposed in accordance with Part 3-Disposal of Excess and Waste Materials.

3.19 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 Division 03 Section "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 Division 03 Section "Cast-in-Place Concrete".

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Place and compact initial backfill as shown on details.

   1. For soil and granular initial backfill: 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.

G. Place and compact final backfill to final subgrade elevation.

H. Install warning tape/detectable warning tape at elevations as shown on the Contract Drawings. Where not shown on the Contract Drawings install warning tape, centered and 12 inches.

I. All pipes shall be protected from lateral displacement and possible damage resulting from backfill operations through, impact or unbalanced loading, by maintaining the pipe adequately embedded as detailed on the Plans. Except where detailed or due to subsoil conditions that require the use of concrete cradle encasement, all pipe embedment shall be placed so as to ensure adequate lateral and vertical stability of the installed pipe during pipe jointing and backfill operations. A sufficient amount of the specified pipe backfill material to hold the pipe in rigid alignment shall be uniformly deposited and thoroughly compacted below, on each side, as well as above each pipe laid in accordance with the limits as shown on the Contract Drawings.

J. Pipe initial backfill shall be granular material or as indicated on the Contract Drawings. Pipe initial backfill materials placed any point below an elevation of 12 inches above the top of the pipe barrel shall be placed and compacted in layers not to exceed 6 inch lifts and shall be done simultaneously and uniformly on both sides of the pipe to the limits as shown on the Contract Drawings. All such materials shall be graded in the trench with hand tools in such a manner that they will be placed uniformly alongside the pipe. Each layer shall be thoroughly compacted to prevent settlement.

K. Trench final backfill when placed under pavements, utilities, buildings and other structures shall be Engineered Fill, Subbase Material or as indicated on the Contract Drawings and shall extend from the top of pipe initial backfill material to the bottom of the subbase. These materials shall be compacted in layers not to exceed 6 inch lifts. Each layer shall be thoroughly compacted to prevent settlement.

L. Trench final backfill outside of pavements, utilities, buildings, and other structures shall consist of common earth backfill or as otherwise shown on the Contract Drawings OR described in the geotechnical report. Backfill shall extend from the top of pipe initial backfill material to the bottom of the topsoil. These backfill materials shall be compacted in layers not to exceed 12-inch lifts after compaction. Each layer shall be thoroughly compacted to prevent settlement.
M. Where trenches are constructed in, near, or across roadway ditches or other watercourses, the backfill shall be protected from surface erosion.

N. Trucks or other heavy equipment shall not be operated over pipelines until a minimum of 24 inches of backfill above the crown of the pipe has been placed and properly compacted.

O. Where pedestrian, bicycle or vehicle traffic is impacted; all trenches within paved areas shall be immediately restored to existing grade with temporary subbase material to allow traffic flow to continue until final restoration is complete.

P. Trench backfill for waterway crossings, if any, shall include 18 inches of medium stone fill rock lining meeting the requirements of this Section.

Q. Do not backfill trenches until tests and inspections have been made and backfilling is authorized by the Architect/Engineer. Use care in backfilling to avoid damage or displacement of pipe systems.

3.20 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 non-granular fill material.
2. Under walks, pavements and exterior slabs, use Subbase Material.
4. Under footings and foundations, use Structural Fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.21 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 3 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 density.

3.22 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Maximum layer depth before compaction:
1. **Under Pavement**: Place backfill and fill soil materials in layers not more than 12 inches in loose depth for material compacted by heavy compaction equipment, and not more than 8 inches in loose depth for material compacted by hand-operated tampers.

2. Place backfill and fill soil materials in layers not more than 12 inches in loose depth for material compacted by heavy compaction equipment, and not more than 8 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 weight density according to ASTM D 1557:

   1. Under structures, building slabs, steps, and pavements: Scarify and re-compact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
   2. Under walkways: Scarify and re-compact top 12 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
   3. Under natural turf or unpaved areas: Compact each layer of subgrade backfill or fill soil material at 85 percent. Compact all layers beneath the upper 2'-0" to at least 95%.
   4. Utility trenches: Compact each layer of initial and final backfill soil material at 85 percent.
   5. Landscape planting areas: Compact each layer of subgrade backfill or fill soil material at 75 percent.

### 3.23 EMBANKMENT CONSTRUCTION (if required)

A. Prior to the placement of materials in fill sections, remove all debris and other deleterious material and stabilize all existing surfaces.

B. Ground surfaces sloped steeper than 1 vertical on 4 horizontal shall be plowed, scarified, stepped, or broken up to permit bonding of the embankment with the existing surface.

C. Uniformly place and spread fill in successive horizontal layers not more than 8-inches in compacted depth for material compacted by heavy compaction equipment, and not more than 4-inches in loose depth for materials compacted by hand operated tampers. Complete compaction to proper density and complete compaction testing prior to placing additional backfill material.

D. The embankment shall be constructed with suitable on-site materials amended as needed to meet application. When on-site material supplies are exhausted, additional suitable imported material shall be used to complete the embankment. The Architect/Engineer shall be the sole judge of what constitutes suitable and unsuitable material.

### 3.24 PREPARATION OF PAVEMENT SUBGRADES

A. Shape the entire subgrade to the required line, grade, and cross slope. Remove any protruding stones larger in diameter than 5 inches and fill the resulting depressions with Subbase Material.

B. Proof-roll the subgrade in accordance with Part 3 Subgrade Inspection. Proofrolling shall be witnessed by the Architect/Engineer or his designated representative. Any loose, soft, wet, frozen, organic, or otherwise unsuitable material shall be removed and replaced with Structural Fill. If
subgrade surface ruts, waves or quakes during proof rolling, recompact or replace unacceptable area and proof roll again. Repeat process until suitable results are obtained as approved by the Architect/Engineer or his designated representative.

C. When pavements cannot be placed immediately after the preparation of the subgrade, the entire, subgrade area shall be restricted to construction traffic until subbase materials can be placed.

D. After rolling, the finished subgrade shall not vary from the established grade and cross slope by more than the tolerance indicated in Part 3-Grading.

E. Do not disturb the finished subgrade by traffic or other operations and protect and maintain in a satisfactory condition until the overlaying granular materials are placed.

F. Any deteriorated subgrade areas that occur during construction are to be removed and repaired by Contractor prior to placement of subbase at no additional cost to Owner.

3.25 STABILIZATION FABRIC (if required)

A. The stabilization fabric shall be placed over subgrade only after the subgrade has been reviewed and limits for fabric established by the Architect/Engineer.

B. The fabric shall be unrolled over the designated subgrade area with a 24-inch overlap at fabric ends and allowing 18-inch overlap on sides. Prior to placement of subbase materials the fabric shall be pulled tight leaving no waves in the fabric.

C. Subbase materials shall be placed on the fabric in such a manner that equipment does not come in contact with the fabric, the fabric remains in tension and no damage to the filter cloth from equipment or subbase materials occurs. All fabric placed shall be covered with fill the same day.

D. Fabric, which becomes damaged prior to covering, shall be removed over its full width and replaced with new fabric, overlapping as stated above.

E. Maintain a minimum of 8 inches loose thickness of aggregate above stabilization fabric subject to traffic.

3.26 SUBBASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course on subgrades free of mud, frost, snow, or ice.

B. Subbase shall be placed to the thickness and limits as shown on the Contract Drawings.

C. On prepared subgrade, place subbase course under pavements and walks as follows:

1. Install separation or stabilization geotextile (where required) on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Shape subbase course to required crown elevations and cross-slope grades.
3. Place subbase course 6 inches or less in compacted thickness in a single layer.
4. Place subbase course that exceeds 12 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 12 inches thick or less than 3 inches thick.
5. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

6. Compact subbase course at optimum moisture content to required grades, lines, cross sections, and thickness. Meet compaction requirements in accordance with this specification.

D. Compaction for driveways or roadways shall proceed in the longitudinal direction to traffic flow and be performed in accordance with NYSS Section 304. Compaction for parking areas shall commence on one side of an area and gradually proceed to the opposite side. When rolling has been completed in one direction, the rolling shall commence in a direction 90 degrees from the first rolling. Bus loops, if any shall be considered as a driveway and shall only be rolled longitudinally.

E. After completion of rolling, no traffic shall be permitted over the compacted course and no hauling other than necessary for bringing material for next course will be allowed. Each compacted course shall be tested with a straight edge 16 feet in length and any depressions greater than 1/4 inch in depth shall be re-graded until the depressions are corrected. The finished surface shall be smooth compact and dry.

F. All voids in the top subbase course shall be removed by re-grading and compacting to the satisfaction of the Architect/Engineer.

G. Thickness tests and compaction tests shall be conducted on the subbase courses. The Contractor shall hand dig holes, not less than 3" in diameter through the subbase, at locations designated by the Architect/Engineer. The Architect/Engineer shall measure the thickness and if any deficiencies are found, they shall be corrected. These tests may be conducted on an average of one test every 200 feet.

3.27 SUB BASE FOR CONCRETE SLABS-ON-GRADE

A. Place sub base on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact sub base under cast-in-place concrete slabs-on-grade as follows:
   1. Place sub base 12 inches or less in compacted thickness in a single layer.
   2. Place sub base that exceeds 12 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 12 inches thick or less than 3 inches thick.
   3. Compact each layer of sub base to required cross sections and thicknesses to not less than 95 percent of maximum dry density according to ASTM D 1557.

3.28 FIELD QUALITY CONTROL AND TESTING

A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections unless otherwise noted.

B. 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.
C. Inspections and tests:

1. Geotechnical observations: Proof rolling procedures, site preparation, unsuitable soils removal, excavations, footing bearing, and fill placement.

2. Field Density Testing:
   
a. 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 Geotechnical Engineer.

b. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
   
   1) Fill under Footings: In each compacted fill layer, perform one compaction test for every 20 linear feet of wall footing. Perform one compaction test under each individual spread footing.
   
   2) Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 50 feet or less of wall length, but no fewer than two tests.
   
   3) Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 1000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
   
   4) Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 20 feet or less of trench length, but no fewer than two tests.

   c. 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. Laboratory testing for on-site fills:
   
a. ASTM D 1557 Modified Proctor compaction curve including sieve analysis.

3.29 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Remove waste materials, including unacceptable/unsuitable excavated material, trash, and debris, and legally dispose off-site.

B. Remove excess excavated material and other materials not specified to be stored, or reused. Dispose off-site at a disposal site approved for the materials.

C. Burning or burial of excess or waste materials at the site is not permitted. Such materials shall be disposed of off-site in conformance with applicable local, state and federal legal requirements.

D. Excess excavated materials may temporarily be stockpiled on-site at a location approved by the Architect/Engineer, OR Owner’s Designated Representative.
E. All costs related to stockpiling, rehandling, transporting, removing and disposal of excess (including suitable and unsuitable) and waste materials shall be paid by the Contractor. Costs shall be included in the price bid.

F. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread and rough grade soil as directed by Owner’s Designated Representative or the Architect/Engineer. Provide erosion control measures.
   1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off-site.

3.30 MAINTENANCE AND PROTECTION OF WORK

A. Protecting Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris. Protect subgrades and foundation soils from freezing temperatures and frosts when atmospheric temperature is lower than 35 degrees F.

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 Owner’s Designated Representative; reshape and recompact.

C. Settling: Where settling is measurable or observable at excavated areas during construction, remove finished surface (pavement, lawn, or other finish areas), add backfill material, compact, and replace/reconstruct surface treatment.
   1. Restore appearance, quality, and condition of finished surface to match adjacent work, and eliminate evidence of restoration to greatest extent possible, at the Contractor's expense.

D. Any backfill or fill materials that settle and/or erode during the general project warranty period shall be repaired by the Contractor upon receipt of written notice from the Owner’s Designated Representative, at no expense to the Owner.
   1. Remove finished surface (pavement, lawn, or other finish areas), add backfill material, compact, and replace/reconstruct surface treatment.
   2. Restore appearance, quality, and condition of finished surface to match adjacent work, and eliminate evidence of restoration to greatest extent possible, at the Contractor's expense.

E. Replace or repair any pipe, structure, or other work, which has been displaced or damaged during construction and general project warranty period at no expense to Owner.

F. Repair to proper grade any settlement of slab, pavement, utility structure, lawn, etc. adversely affected by settlement within general project warranty period at no expense to Owner.

END OF SECTION 312000
SECTION 312500 - EROSION AND SEDIMENT CONTROL

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. Work covered in this section includes the control of erosion, siltation, and sedimentation.

B. This work shall consist of temporary and permanent control measures as shown on the plans or as ordered by the Architect/Engineer during the life of the contract to control soil erosion, siltation, sedimentation and prevent water pollution through use of berms, dikes, dams, sediment basins, fiber mats, netting, gravel, mulches, grasses, slope drains and other erosion control devices or methods.

C. Plans show the suggested minimum measures required. Areas of erosion and sedimentation control measures defined on the plans are not all-inclusive. The Contractor is responsible for utilizing erosion and sedimentation control techniques in all areas of construction where disturbance to existing conditions is required.

D. All appropriate erosion and sediment control measures shall be in place and functional a minimum of five (5) business days before commencement of construction of any segment of the project that requires such measures.

E. Contractor shall protect all storm and sanitary sewers, ditches, swales, drainage channels, etc. and from siltation and sedimentation resulting from work completed under this contract.

F. This project does not require a NYSDEC SPDES General Permit for Stormwater Discharges from Construction Activities (GP-0-15-002).

G. Related Sections:
   1. Division 31 Section "Site Clearing"
   2. Division 31 Section “Earth Moving”
   3. Division 32 Section "Turf and Grasses"

1.3 SUBMITTALS

A. Submit erosion and sediment control sequence schedule based on Contractor’s intended sequencing for review and approval by Architect/Engineer prior to start of construction.

B. Submit actual erosion control measures and excavation dewatering discharge plan based on Contractor intended sequencing for review and approval by Architect/Engineer prior to start of construction. This plan shall also define the maximum disturbed areas per project phase and
show required cuts and fills. Refer to Part 3 - Schedule of Work for additional data to be submitted.

C. Contractor shall provide record plans of all storm piping. Record plans shall provide as a minimum: elevations of all rims and inverts; pipe and structure size and materials of construction; and, elevations and limits of stone at dry wells.

1.4 QUALITY ASSURANCE

A. Work shall be completed in accordance with New York State Standards and Specifications for Erosion and Sediment Control.

B. Provide at least one person who shall be present at all times during erosion control operations and who shall be thoroughly familiar with the types of materials being installed and the best methods for their installation and who shall direct all work performed under this section.

C. Material manufacturers and vendors shall be reputable, qualified firms regularly engaged in producing the required types of materials.

D. Utilize construction methods/techniques, which will limit exposed earthen areas and minimize the effect of earth disturbance activities on soil erosion. There shall not be more than five (5) acres of disturbed soil at any one time without prior written approval from the NYSDEC.

E. Direct all sediment-laden water to an appropriate sediment control device prior to off-site discharge.

F. The Contractor shall maintain all erosion and sediment control measures in good working condition and in accordance with the Contract Documents. The Contractor shall inspect the erosion and sediment control measures, weekly and after each runoff event, to maintain their effectiveness.

1.5 AUTHORITY OF WORK

A. The Architect/Engineer and/or Owner’s Designated Representative may limit the area of clearing and grubbing, excavation, borrow, embankment and/or utility operations in progress, commensurate with the Contractor’s capability and progress in keeping the finish grading, mulching, seeding, and other such permanent or temporary control measures current in accordance with the accepted schedule.

B. The Architect/Engineer and/or Owner’s Designated Representative has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, the surface area of erodible earth material exposed by excavation, borrow, and fill operations, and to direct the Contractor to provide immediate permanent or temporary pollution control measures to minimize damage to adjacent property and to minimize contamination of adjacent streams or other watercourses, lakes, ponds or other areas of water impoundment.
C. In addition, other agencies having jurisdiction over waterway crossings or site erosion control, such as the Corps of Engineers and the NYSDEC, have the authority to make observations at the site to evaluate the construction practices with regard to the approved permits. Any deviation from the requirements of the approved permits will require the approval of the Architect/Engineer, as well as any agencies having jurisdiction.

1.6 PROJECT REQUIREMENTS

A. Take every reasonable precaution and do whatever is necessary to avoid any erosion and to prevent silting of rivers, streams, ponds, impoundments, drainage ditches, and swales.

B. Protect and maintain all areas disturbed by the work, such that erosion is adequately controlled and silt and sediments are not allowed to flow into or onto: any watercourse; adjacent properties; adjacent campus facilities; roadways, parking areas, walkways or other pavements; or, storm or sanitary sewers.

C. Work shall be scheduled to sequence work in such a manner so that the exposed, unprotected surface area of any earth material that is subject to erosion by wind or water will be kept at a minimum.

D. The exposure of uncompleted cut slopes, embankments, trench excavations, and site graded areas shall be kept as short as possible. Initiate seeding and other erosion control measures on each segment as soon as reasonably possible. Temporary and/or permanent stabilization measures shall be implemented within seven days in areas where soil disturbance activities have ceased.

E. Should it become necessary to suspend construction for any length of time, shape all excavated and graded areas in such a manner that runoff will be intercepted and diverted to points where minimal erosion will occur. Provide and maintain temporary erosion and sediment control measures, such as berms, dikes, slope drains, silt stops, and sedimentation basins, until permanent drainage facilities and erosion control features have been completed and are operative.

F. Fine material placed or exposed during the work shall be so handled and treated as to minimize the possibility of its reaching any surface waters. Use diversion channels, dikes, sediment traps, or any other effective control measures.

G. Provide silt stops wherever erosion control measures may not be totally capable of controlling erosion, such as in drainage channels and where slopes may exist.

H. Before water is allowed to flow in any ditch, swale, or channel, install the permanent erosion control measures in the waterway so that the waterway will be safe against erosion.

I. Contractor shall devote particular attention to all (existing and new) drainage facilities, keeping them fully operational at all times. Contractor shall at a minimum inspect and repair siltation controls. Provide inlet protection at existing and new drainage structures.

J. Take special precautions in the use of construction equipment to minimize erosion. Do not leave wheel tracks where erosion might begin. Prevent direct discharge from dewatering pumps and
surface runoff from the construction sites to storm sewers, culverts, streams or ditches. Intercept and conduct surface runoff and discharge from dewatering pumps to siltation ponds before discharging to natural drainage channels.

K. Siltation deposits in storm sewers, surface waters, streams or wetlands resulting from the discharge of water from the project site shall be removed to restore profiles and conditions to that existing prior to the commencement of the work.

L. The Contractor shall keep access routes and parking areas used for the work clean of debris and other obstructions resulting from the work.

M. The Contractor shall keep traveled ways free of foreign objects such as spilled earth, rock, timber, and other items that may fall from transporting vehicles. Materials spilled by or dropped from the undercarriage of any carrying vehicle used in the Contractor’s hauling operations along or across any public or private traveled way shall be removed immediately.

N. Disturbance of lands and waters outside the limits of construction is prohibited, except as may be found necessary and approved by the Architect/Engineer.

O. The requirements of this section also apply to project-related construction activities away from the project site, such as at borrow pits, off-site storage areas, and haul and work roads.

P. Mulching shall follow the seeding operation by not more than 24 hours.

Q. Should any protective measures employed indicate any deficiencies or erosion taking place, immediately provide additional materials or employ different techniques to correct the situation and to prevent subsequent erosion.

R. Continue erosion control measures until the permanent measures have been sufficiently established and are capable of controlling erosion on their own.

S. Comply with all federal, state, and local laws, ordinances, rules, and regulations.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

A Materials shall conform to the design plans or specifications outlined in the New York State Standards and Specifications for Erosion and Sediment Control.

B All materials shall be subject to the approval of the Architect/Engineer and be reasonably clean and free of noxious weeds and deleterious materials.

C Grass shall be a quick growing species suitable to the geographical area as specified in the Contract Documents.

D Fertilizer and soil conditioners shall be standard commercial grade acceptable to the Architect/Engineer.
Trench plug materials shall consist of native soil installed within “sandbags.”

2.2 HAY AND STRAW MULCH

A. General: Hay and straw mulches shall be reasonably free from swamp grass, weeds, twigs, debris, and other deleterious material, and free from rot, mold, primary noxious weed seeds, and rough or woody materials. Mulches containing mature seed of species which would volunteer and be detrimental to the permanent seeding, or would result in overseeding, or would produce growth which is aesthetically unpleasing, is not permitted.

B. Hay Mulch: Properly aired native hay, Sudan grass hay, broomsedge hay, legume hay, or similar hay or grass mowings. When air-dried in the loose state, the contents of the representative bale shall lose not more than fifteen (15) percent of the resulting air-dry weight of the bale. Apply at the rate of 2 to 3 tons/acre, or at 1.5 tons/acre when a net or a mulch stabilizer is used with the mulch.

C. Straw Mulch: Threshed plant residue of oats, wheat, barley, rye, or rice from which grain has been removed. Apply at the rate of 2 to 3 tons/acre or at 1.5 tons/acre when a net or a mulch stabilizer is used with the mulch.

D. Mulch Stabilizers: "Curasol" applied at the rate of 40 gallons/acre, Dow "Mulch Binder" applied at the rate of 45 gallons/acre, or asphalt binder, AASHTO M140, Type SS-1 or RS-1 as applicable, applied at the rate of 400 gallons/acre.

E. Temporary Type Mulch Nets: Paper yard, approximately 0.05” in diameter, woven in to a net with approximate openings of 7/8” by 1/2” and weighing about 0.20 lbs./sy.

F. Permanent Type Mulch Nets: "Vexar" or "Erosion-Net" plastic or nylon mesh netting with approximate openings of 3/8” by 3/4”.

2.3 SEED AND SOD FOR EROSION CONTROL

A. Seed for temporary control: Blend - Mix Type 'A' Rate: 5 to 6 pounds per 1,000 SF

<table>
<thead>
<tr>
<th>Common Names</th>
<th>Parts</th>
<th>Purity</th>
<th>Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adelphi Kentucky Bluegrass</td>
<td>30%</td>
<td>90%</td>
<td>87%</td>
</tr>
<tr>
<td>Baron Kentucky Bluegrass</td>
<td>30%</td>
<td>90%</td>
<td>87%</td>
</tr>
<tr>
<td>Pennlawn Fescue</td>
<td>30%</td>
<td>90%</td>
<td>82%</td>
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<tr>
<td>Pleasure Perennial Ryegrass</td>
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<td>90%</td>
<td>90%</td>
</tr>
</tbody>
</table>

B. For permanent control: See Division 32 Section "Turf and Grasses"
2.4  SILT FENCES

A.  Filter cloth shall be as manufactured by Mirafi 100X, Stabilenka T104N, Indian Valley 3611 Construction Grade or approved equal and shall meet the following requirements:

1.  Silt Fence Fabric:

<table>
<thead>
<tr>
<th>Fabric Properties</th>
<th>Minimum Acceptable Value</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grab Tensile Strength (lbs)</td>
<td>90</td>
<td>ASTM D1682</td>
</tr>
<tr>
<td>Elongation at Failure (%)</td>
<td>50</td>
<td>ASTM D1682</td>
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<tr>
<td>Mullen Burst Strength (lbs)</td>
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<td>ASTM D3786</td>
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<tr>
<td>Puncture Strength (lbs)</td>
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<td>ASTM D3786</td>
</tr>
<tr>
<td>Slurry Flow Rate (gal/min/sf)</td>
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<td>US Std. Sieve</td>
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<tr>
<td>Equivalent Opening Size</td>
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<td>SW-02215</td>
</tr>
<tr>
<td>Ultraviolet Radiation</td>
<td>90</td>
<td>ASTM G-26</td>
</tr>
</tbody>
</table>

B. Other materials shall be as defined on the silt fence detail shown on the Contract Documents.

C. Pre-assembled silt fence, which is complete with U.V., stabilized filter fabric (minimum 36-inch) high-strength polypropylene netting and pre-attached hardwood stakes may also be used. The preassembled reinforced silt fence shall be Silt-LOK 36-100RX as manufactured by JDR Enterprises, Inc., Mirafi Envirofence, Belton Industries or approved equal.

2.5  STABILIZED CONSTRUCTION ENTRANCE

A. Crushed Stone in accordance with Division 31 Section “Earth Moving”.

B. Filter cloth New York State Standards and Specifications for Erosion and Sediment Control for heavy duty haul roads, rough graded, as listed below. Acceptable materials are Trevira Spunbound 1135, Mirafi 600X or equal. The filter cloth shall be woven fabric of only continuous chain polymeric filaments or yarns of polyester. The fabric shall be inert to commonly encountered chemicals, hydrocarbons, mildew; rot resistant and conform to the fabric properties listed below:

<table>
<thead>
<tr>
<th>Rough Fabric Properties</th>
<th>Graded</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grab Tensile Strength (lbs)</td>
<td>220</td>
<td>ASTM D1682</td>
</tr>
<tr>
<td>Elongation at Failure (%)</td>
<td>60</td>
<td>ASTM D1682</td>
</tr>
<tr>
<td>Mullen Burst Strength (lbs)</td>
<td>430</td>
<td>ASTM D3786</td>
</tr>
<tr>
<td>Puncture Strength (lbs)</td>
<td>125</td>
<td>ASTM D751 modified</td>
</tr>
<tr>
<td>Equivalent Opening Size</td>
<td>40-80</td>
<td>US St Sieve</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CW-00215</td>
</tr>
</tbody>
</table>
2.6 INLET PROTECTION

A. Provide masonry or concrete block and clean granular materials, as shown on the contract details.

PART 3 - EXECUTION

3.1 GENERAL

A. In the event of conflict between these specification requirements and pollution control laws, rules or regulations of other Federal, State, or local agencies, the more restrictive laws, rules or regulations shall apply.

B. All appropriate erosion and sedimentation control measures including silt fences and temporary sediment traps shall be in place prior to the excavation of ground vegetation of any segment of the project that requires such measures. All measures shall be maintained throughout the period of construction until vegetation is established to the satisfaction of the Owner’s Designated Representative.

C. Maintenance of said measures shall include periodic removal and disposal of sediment, inspection and repair of damaged facilities, and replacement of any materials required to facilitate revegetation of disturbed areas.

D. Any areas of temporary storage for spoil materials shall be protected by silt fences as directed by the Architect/Engineer and/or Owner’s Designated Representative.

E. Temporary measures such as silt fences and sediment traps shall be removed at the end of construction when vegetation is established to the satisfaction of the Owner’s Designated Representative. Removal of any erosion and sedimentation control measures shall not begin without approval of the Architect/Engineer.

3.2 HAY AND STRAW MULCHING

A. Install hay or straw mulch immediately after each area has been properly prepared. When permanent seed or seed for erosion control is sown prior to placing the mulch, place mulch on seeded areas within 24 hours after seeding. Architect/Engineer may authorize the blowing of chopped mulch provided that 95 percent of the mulch fibers will be 6” or more in length and that it can be applied in such a manner that there will be a minimum amount of matting that would retard the growth of plants. Hay mulch should cover the ground enough to shade it, but the mulch should not be so thick that a person standing cannot see the ground through the mulch. Remove matted mulch or branches.

B. Where mild winds may blow the mulch, or when ground slopes exceed 15 percent, or when otherwise required to maintain the mulch firmly in place, apply a system of pegs and strings, a chemical stabilizer, or temporary type netting to the mulch. Unless otherwise directed, remove the strings and netting prior to the acceptance of the work.

C. Where high winds exist, or heavy rainstorms are likely, or where ground surfaces are steep, or
where other conditions require, apply temporary type netting over the mulch and take whatever measures are necessary to maintain the mulch firmly in place.

D. Unless otherwise specified, the use of permanent type netting is not permitted without the prior approval of the Architect/Engineer.

3.3 SEED FOR EROSION CONTROL

A. Sow seed when soils are moderately dry and when wind does not exceed five miles per hour or as directed by the Architect/Engineer.

B. Areas, which will be re-graded or otherwise disturbed later during construction, may be ordered to be seeded with rye grass to obtain temporary control. The seed shall be sown at the rate of approximately one pound per 1,000 square feet, on the pure live seed basis.

3.4 SILT FENCES

A. Provide silt fences, as required, for the temporary control of erosion and to stop silt and sediment from reaching surface waters, adjacent properties, or entering catch basins, or damaging the work.

B. Erect silt fences and bury bottom edge in accordance with the manufacturer's recommended installation instructions. Provide a sufficient length of fence to accommodate runoff without causing any flooding and to adequately store any silt, sediment, and debris reaching it.

C. Maintain and leave silt fences in place until permanent erosion control measures have stopped all erosion and siltation.

D. Along sloped areas, silt fences shall be placed at spacing not to exceed slope length shown below.

<table>
<thead>
<tr>
<th>Slope Steepness</th>
<th>Maximum Slope Length, Ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2H : 1V</td>
<td>25</td>
</tr>
<tr>
<td>3H : 1V</td>
<td>50</td>
</tr>
<tr>
<td>4H : 1V</td>
<td>75</td>
</tr>
<tr>
<td>5H : 1V or flatter</td>
<td>100</td>
</tr>
</tbody>
</table>

E. Silt fence shall be placed along property boundaries where the grade is such that runoff may occur to adjacent property owners.
3.5 STABILIZED CONSTRUCTION ENTRANCES

A. Stabilized pads of aggregate underlain with filter cloth shall be constructed as shown on the Contract Drawings.

B. Filter cloth shall be placed over the entire area to be covered with aggregate prior to placing of the stone.

3.6 SCHEDULE OF WORK

A. Included with the proposed construction schedule, the Contractor shall submit to the Architect/Engineer for acceptance, his schedules for accomplishment of temporary and permanent erosion control work, as are applicable for clearing and grubbing; grading; installation of utilities, building foundations, retaining walls, ramps, temporary access ways; placement of stone and pavements; and, restoration. In addition, the Contractor shall also submit for acceptance at the same time, his proposed plan for disposal of surplus excavated materials. No work shall be started until the erosion control schedules and methods of operations have been accepted by the Architect/Engineer. If climatic changes occur during construction, the Contractor may be required to submit a revised schedule for acceptance as directed by the Architect/Engineer.

B. Where conditions warrant, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion control features can follow immediately thereafter as the project conditions permit; otherwise temporary erosion control measures may be required between successive construction stages.

3.7 MAINTENANCE

A. If any staples become loosened or raised, or if any matting becomes loose, torn, or undermined, or if any temporary erosion and sediment control measures are disturbed, repair them immediately.

B. If the seed is washed out before germination, repair any damage, refertilize, and reseed.

C. Maintain mulched and matted areas, silt stops, and other temporary control measures until the permanent control measures are established and no further erosion is likely.

D. All sediment spilled, dropped, or washed onto the driveways, roadways, parking areas, walkways or public rights-of-way shall be removed immediately.

E. Maintain ditches and swales at all times so that they effectively drain. Refill, reshape, and recompact where ruts or erosion occurs.

F. Maintain filter fabric placed at inlet grates. Clean and replace as necessary to protect the storm sewers from siltation and sediments.

G. Maintain areas temporarily seeded including repair of all damages, re-seeding, and refertilizing.
H. Flush and clean all storm sewers, structures and sumps. Capture and remove sediments prior to release into other downstream systems.

END OF SECTION 312500
SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

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 temporary excavation support and protection systems.

B. Related Requirements:

1. Section 013233 "Photographic Documentation" for recording preexisting conditions and excavation support and protection system progress.

2. Section 312000 "Earth Moving" for excavating and backfilling, for controlling surface-water runoff and ponding, and for dewatering excavations.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review geotechnical report.

2. Review existing utilities and subsurface conditions.

3. Review coordination for interruption, shutoff, capping, and continuation of utility services.

4. Review proposed excavations.

5. Review proposed equipment.

6. Review monitoring of excavation support and protection system.

7. Review abandonment or removal of excavation support and protection system.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, performance properties, and dimensions of individual components and profiles, and calculations for excavation support and protection system.

B. Delegated-Design Submittal: For excavation support and protection systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:
   1. Land surveyor.
   2. Professional Engineer: Experience with providing delegated-design engineering services of the type indicated, including documentation that engineer is licensed in the state in which Project is located.

B. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Existing Conditions: Using photographs, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

1.6 CLOSEOUT SUBMITTALS

A. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.7 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility-serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
   1. Notify Construction Manager no fewer than two days in advance of proposed interruption of utility.
   2. Do not proceed with interruption of utility without Owner's written permission.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks, and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design excavation support and protection systems to resist all lateral loading and surcharge, including but not limited to, retained soil, groundwater pressure, adjacent building loads, adjacent traffic loads, construction traffic loads, material stockpile loads, and seismic loads, based on the following:
   1. Compliance with OSHA Standards and interpretations, 29 CFR 1926, Subpart P.
3. Compliance with requirements of authorities having jurisdiction.
4. Compliance with utility company requirements.
5. Compliance with railroad requirements.

2.2 MATERIALS

A. Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.

C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application.

E. Shotcrete: Comply with Section 033713 "Shotcrete" for shotcrete materials and mixes, reinforcement, and shotcrete application.

F. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.

G. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

H. Tiebacks: Steel bars, ASTM A 722/A 722M.

I. Tiebacks: Steel strand, ASTM A 416/A 416M.

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 that could develop during excavation support and protection system operations.
   1. Shore, support, and protect utilities encountered.

3.2 INSTALLATION - GENERAL

A. Locate excavation support and protection systems clear of permanent construction, so that construction and finishing of other work is not impeded.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
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 authorities having jurisdiction.

C. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.

3.3 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation.
   1. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement.
   2. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging.
   3. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wood lagging within flanges of soldier piles as excavation proceeds.
   1. Trim excavation as required to install lagging.
   2. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.4 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.

B. Accurately place the piling using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer.
   1. Limit vertical offset of adjacent sheet piling to 60 inches.
   2. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.5 TIEBACKS

A. Drill, install, grout, and tension tiebacks.

B. Test load-carrying capacity of each tieback, and replace and retest deficient tiebacks.
   1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.
C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 BRACING

A. Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
2. Install internal bracing if required to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.7 MAINTENANCE

A. Monitor and maintain excavation support and protection system.

B. Prevent surface water from entering excavations by grading, dikes, or other means.

C. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

3.8 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks daily during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open.

1. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions.
2. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.9 REMOVAL AND REPAIRS

A. Leave excavation support and protection systems permanently in place. Systems must be removed from finished grade or top of slab to a depth of 12 inches below.

END OF SECTION 315000
SECTION 321216 - ASPHALT CONCRETE 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. Work of this Section includes, but is not limited to:
   1. Aggregates
   2. Hot Mix Asphalt Concrete
   3. Liquid Asphalts
   4. Stamped Asphalt

B. Deliver all container materials in manufacturer's standard, unopened containers with labels legible and intact. Store and protect from damage, freezing, or sunlight and heat, if required of individual product.

C. Store all materials and other items where damage and/or contamination will not occur.

D. Related Sections:
   1. Division 31 Section “Earth Moving”

1.3 DEFINITIONS

A. Pavement Area: The full width of hard bituminous road, parking surfaces, and asphalt sidewalks as shown on the Drawings.

B. NYSDOT: New York State Department of Transportation

C. NYSS or NYSDOT Specification Section: New York State Department of Transportation Standard Specifications dated May 1, 2008 (and any subsequent revisions).

1.4 QUALITY ASSURANCE

A. Provide at least one person who shall be present at all times during the execution of this portion of the work, and who shall be thoroughly qualified and experienced in the placing of the type of pavements specified and who shall direct all work performed under this section.

B. Comply with the referenced portions of NYSS.

C. All testing shall be performed by an approved testing laboratory. The Architect/Engineer may use the testing laboratory for inspection services.
D. Use only the materials and job-mix formula approved by the Architect/Engineer. Failure to consistently meet the approved job-mix formula shall be sufficient cause for the Architect/Engineer to prohibit the use of the asphalt supplier.

E. All finished paved surfaces shall be smooth, even, and free from surface defects and irregularities. Edges shall be straight, and shall meet existing pavements smoothly. Pavement shall present a smooth, continuous, and workmanlike appearance, free from patchwork, rough edges, spalling areas, potholes, depressions, bumps, and other defects. The finished installation shall meet with the complete approval of the Architect/Engineer and Owner with respect to appearance as well as structural integrity and other criteria.

F. Bituminous materials shall not be placed on any soft grade, when the grade is wet, when the temperature of the surface on which the mixture is to be placed is below 45°F (below 50°F for 1-inch compacted thickness or less), above 95°F, or when other weather conditions would prevent proper handling or finishing of asphalt mixtures unless otherwise ordered or approved by the Architect/Engineer.

1.5 SOURCE QUALITY CONTROL

A. The asphalt plant shall be approved by the Architect/Engineer.

B. All materials and the asphalt plant will be subject to inspections and tests by the Architect/Engineer and by the approved testing laboratory.

C. Submit sieve analysis of each subbase material from each granular material source.

D. Submit mill analysis of each grade of asphalt from each material source.

1.6 JOB-MIX FORMULA

A. No paving shall commence until a job-mix formula for each asphalt material to be placed has been submitted to and approved by the Architect/Engineer. The required job-mix formula shall be prepared by an approved testing laboratory and shall comply with the NYSS. Provide all testing as required to clearly show that materials meet specification requirements.

B. If a previously established job-mix formula is proposed, certified copies of the mix formula and all test reports made within the last six months by a recognized testing laboratory may be submitted. If the formula and test results comply with these specifications and sufficient evidence of compliance is submitted and is acceptable to the Architect/Engineer, a new job-mix formula will not be required. If insufficient data exists, the Architect/Engineer may request additional testing, or he may require a new job-mix formula.

1.7 SUBMITTALS

A. Proposed job-mix formula and certified materials tests as required under Part 1 – Job Formula shall be submitted.
B. Name, address and telephone number of the asphalt plant proposed for use and a certification that the proposed source conforms to the requirements of these specifications shall be submitted.

C. Evidence shall be submitted indicating that all materials meet the necessary requirements as specified herein.

D. Source quality control information as required in Part 1- Source Quality Control.

E. Certified test reports on tests required under Part 3 of this specification.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Hauling equipment shall conform to NYSS. The Contractor is advised that length of haul, manner of haul, temperature of asphalt, and similar criteria, have a direct bearing on the quality and acceptability of the finished pavements. These other criteria shall be properly controlled such that the job mix of asphalt, when placed, is identical to that specified, approved, and as it left the asphalt plant. Segregation of aggregates, whether occasioned by hauling operations, improper mixing at the asphalt plant, or for other reasons, will result in rejection of the pavement. Clusters and pockets of aggregate in the finished pavement surface, with voids surrounding the aggregates, are unacceptable and will be rejected.

B. All asphalt job mixes shall be delivered to the site and incorporated into the work within the mixing and placing temperature ranges as listed in the NYSS.

C. Subbase granular materials shall be hauled, placed, and graded in a manner to assure good drainage, to preclude the inclusion of foreign matter and to preserve the gradation.

D. Deliver all container materials in manufacturer's standard, unopened containers with labels legible and intact. Store and protect from damage, freezing, or sunlight and heat, if required of individual product.

E. Store all materials and other items where damage and/or contamination will not occur.

1.9 JOB CONDITIONS

A. Asphalt top course shall be placed only during the periods of May 1st up to and including the third Saturday of October when the temperature and conditions are as specified in Part 1- Quality Assurance. Deviations from this time schedule shall be only as approved by the Architect/Engineer.

B. Asphalt concrete pavement shall be installed upon previous courses, which are clean, dry, and free from standing water, and only when weather conditions are suitable.

C. Defective Pavement: Portions of the completed pavement which are defective in finish, compaction or elevation, or that do not comply in all respects with the requirements of the contract documents, shall be taken up, removed and replaced with suitable material, and properly installed in accordance with the contract documents.

D. Environmental Conditions:
1. Prime and Tack Coats: Minimum surface temperature of 60 deg F.
2. Asphalt Binder Course: Minimum surface temperature of 45 deg F and rising at time of placement.
3. Asphalt Top Course: As indicated in Part 1 – Job Conditions and Quality Assurance

E. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials, 50 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 – PRODUCTS

2.1 STONE SUBBASE COURSE

A. The subbase course materials shall consist of granular materials as shown on the Contract Drawings and/or as specified in Division 31 Section “Earth Moving”. Depth as shown on the Contract Drawings.

2.2 BITUMINOUS PAVEMENT

A. Bituminous pavement shall be constructed with approved materials as stipulated in NYSS, Section 400. Job-mix formulas shall be formulated and submitted by the Contractor within the general limits imposed by Table 401-1 from the NYSS Section 401.

B. A binder course shall be placed at a thickness as to produce a required completed thickness when well compacted with a ten (10) ton roller. The material shall be NYSDOT Type 3 Binder. Required completed thickness shall be as shown on the Contract Drawings.

C. A wearing course shall be constructed on top of the binder course and shall produce the required completed thickness when well compacted with a ten (10) ton roller. The material shall be NYSDOT Type 7F Top. Required completed thickness shall be as shown on the Contract Drawings.

D. Base course (where required) shall be placed at a thickness as to produce the required completed thickness when well compacted with a ten (10) ton roller. Base course shall be asphalt base Type 1, in accordance with NYSS Section 401. Required completed thickness shall be as shown on the Contract Drawings.

E. In milled areas, an Asphalt Truing and Leveling course shall be placed on top of the milled surface prior to overlay course. The material shall be NYSDOT Asphalt Truing and Leveling Course. Truing and Leveling Course will not be included in the measurement of completed asphalt thickness.

F. Asphalt tack coat shall conform to NYSS material designation 702-90.

G. Bituminous sealer shall conform to NYSS material designations 702-05 or 702-3401.

H. Bituminous Joint and Crack Filler shall conform with requirements of NYSS material designations 702-0700.
2.3 ASPHALT SIDEWALK

A. All materials shall be as used for bituminous paving except that they shall be placed to the thickness as shown on the contract drawings.

B. A “fine” binder course shall be placed at a thickness as to produce a required completed thickness when well compacted with a ten (10) ton roller. The material shall be Monroe County DOT #1 Binder. Required completed thickness shall be as shown on the Contract Drawings. Binder Content 5.0-6.5. Gradation shall be as follows:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25.0 mm</td>
<td>100</td>
</tr>
<tr>
<td>12.5 mm</td>
<td>90-100</td>
</tr>
<tr>
<td>6.3 mm</td>
<td>60-85</td>
</tr>
<tr>
<td>3.2 mm</td>
<td>42-72</td>
</tr>
<tr>
<td>850 μm</td>
<td>18-42</td>
</tr>
<tr>
<td>425 μm</td>
<td>12-32</td>
</tr>
<tr>
<td>180 μm</td>
<td>6-18</td>
</tr>
<tr>
<td>75 μm</td>
<td>2-8</td>
</tr>
</tbody>
</table>

C. All other materials shall be as used for bituminous paving.

2.4 MMA PAVEMENT SURFACING

A. Pavement markings for crosswalk indicated on the plans shall be Transpo Industries Color Safe Pavement Marking or approved equal.

B. Color Scheme shall be red, blue and white. Red and Blue colors shall be outlined with white. Marking design and colors shall be coordinated with owner prior to placement.

C. Physical properties:

1. Tenisile Strength: 500-1000psi ASTM D638 Type 1
2. Elongation: >30% ASTM D638 Type 1
3. Hardness: 55-60 Shore D ASTM D2240
4. Water Absorption: <0.25% ASTM D570
5. Pot Life @72 deg F: 15 Minutes ASTM T237
6. Solid Content: 100% ASTM D1644
7. Aggregate: #0 silica
8. Hardness: 7.0 Mohs Scale

2.5 MIXES

A. All bituminous concrete shall be mixed at the approved asphalt mixing plant in accordance with NYSS.

2.6 PAVEMENT STABILIZATION GEOTEXTILE FABRIC
A. The pavement stabilization geotextile materials shall be in accordance with Division 31 Section “Earth Moving”.

2.7 PAVEMENT MARKING PAINT

A. Pavement marking paints for roadway centerline, bus loop and crosswalks shall conform to standards for reflectorized roadway striping. Epoxy reflectorized pavement striping is not required. Markings shall be yellow or white as indicated on the drawings.

B. Glass beads for use in reflectorized pavement marking paints shall conform to NYS DOT Specification 727-05.

C. Pavement striping for parking and lettering shall conform to roadway striping except that no glass beads are required. Markings for lettering shall be white in color. Marking for parking shall be yellow in color.

PART 3 - EXECUTION

3.1 GENERAL

A. Prior to the work of this section, verify that all utility, piping and grading work is complete, tested and approved by the Architect/Engineer and to the point where pavement installation may be properly performed. Particular attention is given to items such as pipelines or conduits so as to avoid excavating pavements at a later date.

B. Joints, where required, due to the discontinuation of work, shall be well bonded and sealed in such a manner as to create an integral appearance. Joints in successive courses shall be offset a minimum of two (2) feet horizontally from the lower pavement course. Transverse and longitudinal joints shall be performed in accordance with NYSS Section 401. Care shall be taken by workmen at all times to avoid walking on freshly spread material.

C. Where, curbs, pavers, concrete sidewalk, manholes or other objects come in contact with the pavement, they shall receive a uniform coating of an asphalt tack coat. The asphalt coating shall be applied according to the manufacturer's recommendations but in no case shall it be applied above the elevation of the abutting asphalt materials.

D. All asphalt material shall be placed in a uniform layer by an approved bituminous paver. Hand placement may be permitted in small irregularly shaped areas, which are not accessible to a paver, only with prior Architect/Engineer approval.

E. Each days paving (base, binder or top) shall begin from a straight saw cut joint approved by the Architect/Engineer.

F. Joints at existing pavements shall be vertically sawcut. Apply tack coat on surfaces as shown on joint detail of Contract Drawings before beginning placement of new material. New material surfaces shall match existing surface.

G. 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.

H. 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.

I. 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.

J. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

K. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.2 SUBGRADE PREPARATION

A. Subgrade shall be prepared in accordance with Division 31 Section “Earth Moving”.

B. The Architect/Engineer may require a field demonstration of compaction equipment before approving subgrade. Rolling and compacting shall be done in the longitudinal direction of the traffic flow. If the moisture content of the soil is outside of the limits required to achieve the required compaction in accordance with Division 31 Section “Earth Moving”, the Architect/Engineer will require the addition of water or discing and re-grading so that the required degree of compaction shall be achieved. Obtain Architect/Engineer's approval of subgrade prior to placing subbase course or geotextile fabric (if fabric is required).

3.3 STABILIZATION FABRIC

A. Geotextile shall be installed in accordance with Division 31 Section “Earth Moving”.

3.4 SUBBASE COURSE INSTALLATION

A. Subbase course shall be prepared in accordance with Division 31 Section “Earth Moving”.

3.5 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).
   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.

3.6 BASE COURSE INSTALLATION (if required)
A. Asphalt concrete base course, as required by the Contract Documents, shall be placed to thickness and limits as shown on the Contract Drawings and only upon an Architect/Engineer approved subbase grade.

B. Compact the base course as specified in NYSS Section 401. In areas where rollers are inaccessible, compaction shall be effected with hand tampers or gas-fired compactors weighing not less than 25 pounds and having a bearing area not greater than 48 square inches.

C. Care shall be taken when rolling adjacent to a curb, sidewalk, light pole or other structure. Damage to any structure shall be repaired or replaced by the Contractor as ordered by the Architect/Engineer at no additional cost to the Owner.

D. The surface shall be tested with a 16-foot straight edge and all variations exceeding 1/4 inch in height or depth shall be eliminated.

3.7 BINDER COURSE INSTALLATION

A. Asphalt binder shall be placed to the thickness and limits as shown on the Contract Drawings and only upon an Architect/Engineer approved subbase grade (where no base course) or approved base course.

B. The roadway or sidewalk base surface to be covered shall be free from holes, depressions, bumps, waves, and corrugations. Any unsuitable surface areas or where directed by the Architect/Engineer shall be repaired by replacement of the unstable materials or by patching with a material to produce a tight surface having the correct grade. The roadway surface shall be cleaned by the use of mechanical sweepers, hand brooms, or other effective means until the surfaces are free of all material, which might interfere with the bond between the overlay material and the existing surfaces. All cleaning equipment shall be approved by the Architect/Engineer prior to use. Cleaning shall continue until adequate cleaning results as determined by the Architect/Engineer. Cleaning shall be done immediately prior to overlaying at no additional cost to the Owner.

C. Compact the binder course as specified in NYSS Section 401. In areas where rollers are inaccessible, compaction shall be effected with hand tampers or gas-fired compactors weighing not less than 25 pounds and having a bearing area not greater than 48 square inches.

D. Care shall be taken when rolling adjacent to a curb, sidewalk, light pole or other structure. Damage to any structure shall be repaired or replaced by the Contractor as ordered by the Architect/Engineer at no additional cost to the Owner.

E. The surface shall be tested with a 16-foot straight edge and all variations exceeding 1/4 inch in height or depth shall be eliminated.

3.8 TOP COURSE INSTALLATION

A. Asphalt top course shall be placed only during the periods indicated in Part 1 Job Conditions.

B. The roadway or sidewalk binder surface to be covered shall be free from holes, depressions, bumps, waves, and corrugations. Any unsuitable surface areas or where directed by the Architect/Engineer shall be repaired by replacement of the unstable materials or by patching with a material to produce
a tight surface having the correct grade. The roadway surface shall be cleaned by the use of mechanical sweepers, hand brooms, or other effective means until the surfaces are free of all material, which might interfere with the bond between the overlay material and the existing surfaces. All cleaning equipment shall be approved by the Architect/Engineer prior to use. Cleaning shall continue until adequate cleaning results as determined by the Architect/Engineer. Cleaning shall be done immediately prior to overlaying at no additional cost to the Owner.

C. The Contractor shall coordinate the application of the upper courses for new and existing asphaltic pavements so that the finished surface of both top courses will be uniformly level. Any irregularities or depressions in the existing pavement shall be corrected by placing additional asphaltic concrete.

D. Roll the asphalt top course with a minimum ten ton roller, or as specified by the NYSS.

E. The finished pavement shall present a continuous and even appearance from edge of pavement to edge of pavement. The top course shall be blended in to meet existing pavements where applicable.

F. The surface shall be tested with a 16-foot straight edge and all variations exceeding 1/4 inch in height or depth shall be eliminated.

3.9 MANHOLE CASTINGS AND OTHER APPURTENANCES

A. Manhole frames and covers, valve boxes, cleanout covers, catch basin frames and grates and dry well frames and grates shall be set so that the finished asphalt top course is 1/4 inch above each. In no case shall these frames and covers, boxes or grates protrude above the finish pavement surface. Likewise these appurtenances shall not sit in depressions nor be paved over. Prior to completion of finished pavement, all castings and appurtenances shall be protected from damage by the Contractor.

3.10 PAVEMENT MARKINGS

A. The Contractor shall paint solid markings using two coats of paint in those areas indicated on the contract drawings and as, hereinafter, specified. Markings shall be painted immediately after all aspects of the paving operations have been completed and before dirt can accumulate on the pavement surface.

B. Protection: Install adequate barricades at points where trespassing can occur immediately after paving is completed so as to prevent vehicles or pedestrians from impeding the painting, operation.

C. Method: Carefully layout and define all painted markings on the surface of the pavement by means of chalk markings before painting, and accurately paint all markings within the limits and to the dimensions indicated on the contract drawings. All surfaces must be thoroughly cleaned before markings are painted.

All markings shall be clear and distinct with sharply defined edges. Apply two coats of paint. At least 24 hours shall elapse between the painting of the first and second coats.

D. Removal of Equipment: Upon completion of the painting operation and once the paint has dried, remove all barricades and other debris, which has resulted from this operation.
E. Cleanup: Remove all spilled paint, tracking marks and unauthorized markings.

3.11 MMA PAVEMENT SURFACING

A. The Contractor shall apply MMA pavement surfacing in accordance with manufacturer’s recommendations and in those areas indicated on the contract drawings. Markings shall be applied 30 days after paving operations have been completed and on a cleaned pavement surface.

1. Protection: Install adequate barricades at points where trespassing can occur immediately after paving is completed so as to prevent vehicles or pedestrians from impeding the pavement marking installation.

2. Method: Carefully layout all areas before applying MMA pavement surfacing to the dimensions indicated on the contract drawings. All surfaces must be thoroughly cleaned before application of MMA pavement surfacing and apply masking to those areas. Mix ingredients thoroughly and place them in the specified areas. Spread materials evenly with squeegees and roll until the there is a uniform even finish.

3. Removal of Equipment: Upon completion of placement, remove all barricades and other debris, which has resulted from this operation.

4. Cleanup: Remove all unauthorized markings.

3.12 WEATHER AND SEASONAL LIMITATIONS

A. Contractor shall schedule paving operations such that all paving necessary to provide safe and adequate maintenance and protection of traffic or for the protection of previously laid course is completed within the weather and seasonal limitation described previously.

B. Scheduling and sequencing of work to conform to seasonal limitations shall be reflected in the price bid.

C. If paving operations are not completed within the weather and seasonal limitations, all temporary materials and work needed (e.g. shimming of castings and protrusions, adequate drainage etc.) to provide acceptable ride-ability, and maintenance and protection of traffic shall be provided by the Contractor until paving operations can be completed at no additional cost to the Owner.

D. Base or binder course, placed by the Contractor, which will be permanently incorporated into the work and left open to traffic over the winter, shall be cleaned and tack coated in accordance with NYSS. Cleaning and tack coat shall be done immediately prior to overlaying at no additional cost to the Owner.

E. If the Contractor requests a waiver of the seasonal limitations and the Architect/Engineer determines it to be in the best interest of the Owner, the seasonal limitations may be waived for a limited period of time subject to temperature, time, weather and other conditions. Conditions of seasonal waiver shall include, but not be limited to, withholding of payment for work performed beyond the seasonal limitation date pending determination of the pavement condition and performance during the following spring; and, delaying start of one-year warranty period.
F. Contractor shall have no claim against the Owner for any costs attributable to disapproval of a waiver request. Architect/Engineer decision for approval or disapproval is final.

G. Any pavement damage which occurs as a result of Contractor either not protecting previously laid course or constructing any pavement course outside weather or seasonal limits whether a waiver was granted or not, shall be repaired or replaced as determined by the Architect/Engineer at no additional cost to the Owner. All repairs or replacements shall be completed to the satisfaction of the Architect/Engineer and in accordance with these specifications.

3.13 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate subbase course to form new subgrade.

B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving 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.

C. Patching: Partially fill excavated pavements with hot-mix asphalt binder mix and, while still hot, compact. Cover asphalt binder course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.14 WARRANTY

A. Settlement: Any settlement exceeding 1/8-inch in 10 feet horizontally or ¼-inch total depression, which occurs in any asphalt work within one year after final acceptance, shall be entirely removed and brought to proper grade and repaired, to the satisfaction of the Architect/Engineer.

B. If ponding or negative drainage patterns occur during within one year after final acceptance, the area shall be repaired to the satisfaction of the Architect/Engineer at no additional cost to the Owner.

END OF SECTION 321216
SECTION 321313 - CONCRETE PAVEMENT, SIDEWALKS AND CURBING

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. Extent of concrete pavement work includes, but is not limited to furnishing and placing complete the following:
   1. 5-inch depth concrete sidewalk.
   2. 6-inch depth reinforced concrete sidewalk
   3. Concrete curbing
   4. Place pre-molded bituminous joint filler to complete the concrete sidewalk and pavements

B. Work for other cast-in-place slabs shall be completed in accordance with Division 03 Section “Cast in Place Concrete.

C. Related Sections:
   1. Division 03 Section “Cast-in-Place Concrete”
   2. Division 32 Section “Asphalt Concrete Paving”
   3. Division 31 Section “Earth Moving”

1.3 QUALITY ASSURANCE

A. Concrete shall be tested in accordance with Part 3 - Quality Control Testing During Construction, of this specification. Materials and Testing Laboratory services shall be paid by the Owner for testing concrete cylinders for compressive strength. All concrete not meeting the proper requirements shall be removed from the site by the Contractor. Additional testing as required in accordance with Part 3 shall be the responsibility of the Contractor.

B. All materials and work to prepare, form, place, finish, test, seal and cure the concrete sidewalk shall be completed in accordance with NYSDOT Specification Section 608 and as shown on the Contract Plans.

C. Installer Qualifications: An experienced installer who has completed pavement work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

D. ACI Publications: Comply with the following, unless more stringent provisions are indicated:
   1. ACI 301, “Specification for Structural Concrete”.
1.4 SUBMITTALS

A. Submit proposed concrete mix design and laboratory test reports on mix design.

B. Submit manufacturer's catalog cuts, technical data, and recommendations on quantities, installation, and application for the following:
   1. Formwork accessories.
   2. Concrete admixtures.
   5. Joint fillers and joint filler strips
   6. Curing and sealing compounds

C. Submit concrete placement schedule prior to start of any concrete placement operations. Include location of all joints indicated on drawings, plus anticipated construction joints.

D. Steel Reinforcement Shop Drawings: Details of fabrication, bending, and placement, prepared according to ACI 315, “Details and Detailing of Concrete Reinforcement.” Include material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement and support of concrete reinforcement. Include special reinforcement required for openings through concrete structures.

E. Mockup: Cast full-size sections (8 feet x 8 feet minimum) for each form and pattern of sidewalk or concrete pavement required, to demonstrate aesthetic effects as well as qualities of materials and execution (typical joints, surface finish, typical pattern, texture, color, and standard of workmanship). Build mockups to comply with the following requirements, using materials indicated for final unit of Work, including same base construction, special features for expansion joints, and contiguous work as indicated.
   1. Locate mockups on-site in the location and of the size indicated or, if not indicated, as directed by Architect/Engineer.
   2. Notify Architect/Engineer one week in advance of the dates and times when mockups will be constructed.
   3. Demonstrate the proposed range of aesthetic effects and workmanship.
   4. Obtain Architect/Engineer's acceptance of mockups before start of final unit of Work.
   5. If Architect/Engineer determines that mockups do not meet requirements, demolish and remove them from site and cast another until mockup is approved.
   6. Retain and maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   7. Accepted mockups in an undisturbed condition at the time of Substantial Completion may become part of the completed Work.

1.5 DELIVERY, HANDLING, STORAGE

A. Deliver all container materials in manufacturer's standard, unopened containers with labels legible and intact. Store and protect from damage, freezing, or sunlight and heat, if required of individual product.

B. Store all aggregates and other items where damage and/or contamination will not occur.
C. Deliver, store and handle steel reinforcement to prevent bending and damage.

1.6 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for: other construction activities; access to Campus facilities; and, safety for workers, Campus employees and general public.

PART 2 – PRODUCTS

2.1 SUBBASE

A. The subbase course materials shall consist of granular materials as shown on the Contract Drawings and/or as specified in Division 31 Section “Earth Moving”. Depth as shown on the Contract Drawings.

2.2 CONCRETE FOR PAVEMENT, SIDEWALKS AND SIDEWALKS WITH INTEGRAL CURB

A. Readymix concrete conforming to ASTM C94 and this specification will be approved if obtained from an established contractor.

B. All concrete shall have minimum 28-day strength of 4,500 psi, conforming to ASTM C94.

Concrete shall have:
1. Water/Cement Ratio by wt. 0.48
2. Slump 3 ± 1 inches
3. Air Content 6.0 ± 1%
5. Sand: Shall be clean, sharp, natural sand, conforming to ASTM C-33-67. Material finer than #200 sieve shall not exceed 3 percent. Sand shall conform to NYSDOT Table 703-07 size designation.
6. Aggregate: Shall be clean, strong, crushed limestone or natural washed gravel conforming to NYSDOT #1 (Table 703-4) as follows:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch</td>
<td>100%</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>90 - 100%</td>
</tr>
<tr>
<td>1/4</td>
<td>0 - 15%</td>
</tr>
</tbody>
</table>


8. High Range, Water-Reducing Admixture: ASTM C494, Type F
9. Water-Reducing and Retarding Admixture: ASTM C494, Type A
10. Water: Water for concrete shall comply with NYS Department of Health Standards for drinking water.
3. Concrete Accessories:

1. Surface Sealant: Shall be a transparent, non-yellowing, waterborne, membrane-forming sealing compound meeting ASTM 1315, Type 1, Class A sealer for exterior use, such as Kure-N-Seal W by Sonneborn or other as approved by Architect/Engineer.

2. Expansion Joint Filler (horizontal and vertical): Use in conjunction with "Zip-strip" preformed recess strips. Filler shall be a non-impregnated cane fiber-preformed of thickness shown on Contract drawings (Closed cell, semi-rigid foam is an acceptable alternate).

3. Expansion Joint Sealer: Shall be a pour grade one-part, self-leveling polyurethane sealant, such as Sonneborn Sonolastic SL1. Light gray in color. Use compatible primer where suggested by manufacturer.


5. Reinforcing Bars: ANSI/ASTM A615, Grade 60, deformed.

6. Supports: Provide supports for reinforcement (welded wire mesh & reinforcing bars) including bolsters, chairs, spacers and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI recommendations, unless otherwise accepted. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.

7. Tie Wire: 16 gauge black steel.

2.3 CONCRETE FOR CONVENTIONALLY FORMED CONCRETE CURB

A. Concrete - shall conform to the concrete as described for concrete pavement and sidewalks of this specification.

B. Curing Compounds - shall conform to NYSDOT (711-05) membrane curing compounds clear with fugitive dye, and shall be on the NYSDOT approved list latest edition.

C. Expansion Joints - At ends and at 20 foot maximum intervals, fill with cellular compression material 1/2 thick to within 1/4 inch of top of face. Cut to conform to cross-section of curb and place vertical. Material shall conform to ASTM D1751 pre-molded, bituminous impregnated material. When curb is cast adjacent to cement concrete pavement constructed with expansion joints, expansion joints in the curb shall be located at the expansion joints in the pavement.

2.4 CONCRETE FOR MACHINE FORMED CONCRETE CURB

A. The material requirements, mix preparation and manufacturing of concrete shall comply with the requirements for Class J concrete Section 501 - Portland Cement as defined in the NYSDOT "Standard Specifications," as issued May 2008 (and any subsequent revisions).
2.5 CONCRETE FORMS

A. Forms shall be steel or plywood with finished surface in contact with concrete. Forms shall be free of warps or kinks.

B. All forms shall be of suitable size and strength, braced and secured adequately to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. All forms shall extend for the full curb depth.

C. Use straight forms, free of distortion and defects. Use flexible spring steel forms or laminated boards to form radius bends as required.

D. Coat forms with a non-staining form release agent that will not discolor or deface surface of concrete and will not impair subsequent treatments of concrete surfaces.

2.6 CURING MATERIALS


2.7 CONTROL OF CONCRETE MIXING IN THE FIELD

A. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94. Furnish batch ticket information to concrete testing representative.

1. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 GENERAL - POURED IN PLACE CONCRETE

A. The contractor is responsible for the complete construction and/or installation of all concrete walks, curbs and other concrete work in accordance with the contract drawings and this specification.

B. Provide materials necessary to ensure adequate protection of concrete during inclement weather before beginning installation of concrete.

C. Before beginning concrete placement, inspect formwork, reinforcing steel, and items to be embedded, verifying that all such work has been completed.

D. If needed, provide runways for wheeled equipment to convey concrete. Do not support runways on reinforcing or wheel equipment directly over reinforcing.

E. Schedule continuous placement of concrete to prevent the formation of cold joints. Provide construction joints if concrete for a particular element or component cannot be placed in a continuous operation.

F. Deposit concrete as close as possible to its final location, to avoid segregation.
G. Concrete sidewalks shall be protected from damage, by temporary asphalt until such time as the final asphalt is placed.
3.2 PREPARATION

A. **Subgrade:** All large stone, organic material, soft clay, spongy material and other deleterious matter exposed during the course of preparing the subgrade shall be excavated and replaced with the specified base course material. The subgrade shall be properly shaped and uniformly compacted to conform with the accepted section, line and grade as indicated on the contract drawings.

B. **Aggregate Subbase Course:** The subbase course for concrete pavements shall consist of compacted aggregate placed on the prepared subgrade to the depths indicated on the contract drawings. Roll or tamp aggregate with an approved power roller or mechanical tamper until it is firmly compacted and meets compaction requirements listed in Division 31 Section “Earth Moving”.

C. Remove loose material from compacted subbase prior to concrete placement.

3.3 FORM CONSTRUCTION

A. Forms shall be full depth, set accurately to line and grade, and be securely staked and held in position throughout placing and curing of concrete. Contractor shall obtain approval of forms for horizontal alignment from the Architect/Engineer prior to placing concrete.

B. Clean forms after each use and coat with form releasing agent as often as required to ensure separation from concrete without damage.

C. Allowable tolerances:
   i. Top of forms not more than 1/8” in 10’
   ii. Vertical face on longitudinal axis, not more that ¼” in 10’

3.4 REINFORCEMENT

A. Wire fabric for concrete reinforcement shall be embedded at mid-depth in the slab. Immediately prior to placing concrete, place all required reinforcing in the forms in accordance with the Contract Drawings. Place reinforcing mesh in such a manner that sheets of mesh overlap adjoining sheets by a minimum of 6 inches both longitudinally and transversely. Place mesh on brick chairs 2 inches above the surface of the subgrade. No reinforcing shall cross expansion joints. Any mesh bent, displaced or ruptured during handling shall be straightened or rewelded.

B. All outside edges of mesh (or reinforcing) shall not be more than 3 inches or less than 1-1/2 inches from the finished edges of the pavement.

3.5 CONCRETE PLACEMENT

A. Do not place concrete until subbase and forms have been checked for line and grade. Do not place concrete around manholes or other structures until they are at required finished elevation and alignment.

B. The subbase shall be wetted immediately prior to placing the concrete for the sidewalk and exterior slabs. Place concrete in the forms to the full depth as indicated on the Contract Drawings and thoroughly vibrate or tamp, ensuring that all honeycombing is eliminated and the surface of the
concrete is true to line and grade. Do not use vibrators to move concrete laterally. Consolidate with care to prevent dislocation of reinforcing, dowels or joint devices.

C. Deposit and spread concrete in a continuous operation.

D. Place all concrete in forms within 45 minutes of mixing. Discard any concrete in which an initial set has occurred prior to placing.

E. No retempering of concrete will be permitted and concrete shall not be dropped more than 3 feet.

3.6 JOINTS

A. When joining existing structures, sidewalks or other pavements place transverse joints to align with previously placed joints, unless otherwise directed.

B. Provide full depth premolded bituminous joint filler for expansion joints every 20 feet. Intervals in pavement surfaces shall not exceed 20 feet on center in any direction. Expansion joints shall go through curb as well and to the full depth of curb. In addition, place expansion joints wherever concrete pavement abuts curbs, catch basins, inlets, structures, existing walks, building walls, retaining walls, stairs, and, other fixed objects. Joint filler shall be held securely in place so that straight joints results. All expansion joints shall be keyed.

C. Extend joint fillers full width and depth of joint, not less than 1/2” or more than 1” below finished surface where joint sealer is indicated. If no joint sealer, place top of joint filler flush with finished concrete surface.

D. Protect top edge of joint filler during concrete placement with a metal cap or other temporary material. Remove protection after concrete has been placed on both sides of joint.

E. Allow concrete pavement to cure a minimum of 10 days prior to the time of installation of joint sealer. Install joint sealer after joint is thoroughly clean and one application of primer has been uniformly and continuously applied and thoroughly dried.

F. Tooled control joints shall be placed every 5 feet. The jointer for tooled joints shall have a 3/4 inch to 1 inch deep bit, with 1/4 inch to 1/2-inch radius. Control Joints shall be performed as soon as possible after slab finishing without possibility of dislodging aggregate.

G. Joints shall be straight. Joints not straight will require removal of the concrete and replacement.

3.7 CONCRETE FINISHING FOR SIDEWALKS AND RAMPS

A. Strikeoff to required grade and within surface tolerances indicated. Verify conformance to surface tolerances. Correct deficiencies while concrete is still plastic.

B. Bull Floating: Immediately following screeding, bull float or darby before bleed water appears, to eliminate ridges, remove surface irregularities, fill in voids, and embed coarse aggregate. Recheck and correct surface tolerances. Refloat repaired areas to provide continuous smooth finish. Surface
shall be smooth, even finish, free of any design swirls, float marks etc. Use hand methods only where mechanical floating is not possible.

C. Work edges of slabs and formed joints with a edging tool, and round to 1/2" radius, unless otherwise indicated. Eliminate tool marks on concrete surface.

D. Do not perform subsequent finishing until excess moisture or bleed water has disappeared and concrete will support either foot pressure with less than ¼-inch indentation or weight of power floats without damaging flatness. Complete surface finish as follows:

1. For sidewalks and ramps provide a broom finish by drawing a stiff bristle broom across concrete surface, perpendicular to line of traffic. Provide uniform transverse corrugations approximately 1/16 inch deep, without tearing surface. Repeat operation if required to provide a line texture acceptable to the Architect/Engineer.

2. For ramps and flares only also provide a tooled grooved finish.

3. Finish in accordance with the pattern indicated on the contract drawings.

E. All pavement edges shall be tooled to round. Along each side of expansion joints, use Goldblatt Edger 2 inches wide, 3/8 inch radius, 1/2 inch lip, Catalogue No. 06260M7 or approved equal. For score joints, use Goldblatt bronze groover bit size 1/2 inch at top, 1 inch deep, 4-1/2 inches wide, Catalogue No. 0631M7 or approved equal.

F. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point-up any minor honeycombed areas. Rub all exposed surfaces of concrete. Remove and replace areas or sections with major defects, as directed by the Architect/Engineer.

G. All lines formed shall be true and straight. The walk surface shall have finish as noted above with exposed tooled edge and joint banding, flush with broomed finish, and free of all ridges.

H. Curb face shall be hand rubbed to remove all form markings.

3.8 CURING

A. Curing of the sidewalk and curb shall comply with the requirements of NYSDOT Section 502-3.10. Minimum curing periods for the various types of curing materials used shall comply with the requirements of Table 502-2 in NYSDOT Section 502 latest edition.

B. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

C. Apply curing compound to all exposed surfaces immediately after finishing operations are completed and surface water has evaporated. Provide curing covers over forms.

D. The manufacturer’s recommendation for application and use of the curing material shall be observed.

E. Protect all concrete work from traffic and the elements, for a minimum of three days. Do not open
pavement to traffic until the Architect/Engineer so directs. Minimum curing periods for the various types of curing materials used shall comply with the requirements of Table 502-2 in NYSDOT Section 502 latest edition.

3.9 SURFACE SEALANT

A. Immediately upon completion of the concrete curing period apply two coats surface sealant, by means of an approved mechanical pressure spray distributor, capable of maintaining a pressure of 20 to 30 pounds per square inch, to pavement surfaces, which have been cleaned and thoroughly dried. Apply each coat of surface sealant, at the rate specified by the manufacturer, to all exposed surfaces of exterior concrete. Allow specified time to dry thoroughly between applications.

B. Exercise care in the use of surface sealant solution and avoid causing damage or harm to property and persons in the immediate vicinity of the spray operation.

3.10 SLAB SURFACE TOLERANCES:

1. Achieve flat, level planes except where grades are indicated. Slope uniformly to drains.
2. Floated finishes: Depressions between high spots shall not exceed 5/16 inch under a 10-foot straightedge.

3.11 WORKMANSHIP

A. All concrete work shall be first quality and in strict accordance with line and grade and the dimensions indicated on the contract drawings. The average thickness of concrete pavement shall not be deficient by more than 1/4 inch. Any concrete work not constructed or installed in accordance with the contract drawings will not be accepted and shall be removed and replaced at the contractor's expense.

B. Seasonal Limits: No concrete shall be poured on a frozen or thawing subgrade during inclement weather or when the temperature of the air is less than 38 degrees F.

C. Protect all concrete surfaces from traffic and the actions of the elements until surface sealant solutions completely dry. Provide barricades and/or fencing when required for a minimum period of 4 hours, or as directed by the Architect/Engineer.

D. All horizontal and vertical alignments shall be smooth. No abrupt changes in grade or horizontal alignment will be accepted.

3.12 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Bases and Foundations: Provide equipment bases and foundations as shown on Drawings. Set anchor bolts for equipment at correct elevations, complying with diagrams or templates from
3.13 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect/Engineer. Remove and replace concrete that cannot be repaired and patched to Architect/Engineer’s approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than ½ inch (13 mm) in any dimension in solid concrete, but not less than 1 inch (25 mm) in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect/Engineer.

3.14 REMOVAL OF EXISTING CONCRETE

A. Saw cut surfaces or drill holes at regular intervals sufficient to establish a fracture plane for removal by power tools.

B. Salvage all existing reinforcing; do not cut away until specifically directed by the Architect/Engineer, or as shown on the Drawings.

C. New work bonded to existing work:

1. Clean and roughen existing surface by sandblasting, waterblasting, scabblers, or other approved method.
2. Embed dowels and reinforcing as detailed on the Drawings.
3. Coat surface with bonding agent applied in strict accordance with manufacturer's instructions.
D. Existing work cut away for new work.
   1. Saw cutting and removal shall continue to within 1/4 inch of the finished surface. The final ¼-inch removal shall be completed by grinding to the final surface.
   2. Provide bond breaker where new concrete work is adjacent to existing work but structurally separate.

3.15 COLD WEATHER CONCRETING

A. Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions or low temperatures, in compliance with requirements of ACI 306 and as specified.

B. Cold weather concreting (below 40º F) shall conform to ACI 306-72. Section 6.2 shall not apply.

C. When air temperature has fallen to or is expected to fall below 40º F, provide adequate means to maintain temperature in area where concrete is being placed at 70º F for five days or 50º F for seven days after placing. Sudden thermal shock due to rapid heating or cooling and rapid dry out due to overheating shall be avoided.

D. When air temperature has fallen to or is expected to fall below 40º F uniformly heat water and aggregates before mixing, as required, to obtain concrete mixture temperature of not less than 50º F or more than 80º F at time of placement. ACI 306-72, Chapter 2 shall apply only if approved by the Architect/Engineer.

E. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Forms, reinforcing steel and adjacent concrete surfaces shall be entirely free of frost, snow and ice before placing.

3.16 HOT WEATHER CONCRETING

A. When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305-72 and as specified.

B. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90º F. Mixing water may be chilled or chopped ice may be used to control concrete temperature. Water added to mix shall be reduced by water content of ice.

C. Cover reinforcing steel with water soaked burlap if it becomes too hot. Steel temperature shall not exceed air temperature at time of embedment.

D. Wet forms thoroughly before placing concrete.

E. Do not use retarding admixtures without written approval of Architect/Engineer.
QUALITY CONTROL TESTING DURING CONSTRUCTION

A. Contractor shall provide free access to Work and cooperate with appointed testing firm.

B. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement. Tests will be performed according to ACI 301.

C. The following tests may be performed by the Owner:

1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.

2. Slump: ASTM C 143; one test for each concrete load at point of discharge; and one test for each set of compressive strength test specimens.

3. Air Content: ASTM C 173; volumetric method for lightweight of normal weight concrete; ASTM C 231 pressure for normal weight concrete; one for each set of compressive strength test specimens.

4. Concrete Temperature: Test hourly when air temperature is 40°F (4°C) and below, and when 80°F (27°C) and above; and each time a set of compression test specimens are made.

5. Compression Test Specimen: ASTM C 31; One composite sample (minimum of 4 cylinders) for each day's pour of each concrete mix exceeding 5 cu. yd, but less than 25 cu. yd., plus one set of four standard cylinders for each additional 50 cu. yd. or fraction thereof. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required. One additional test cylinder will be taken during cold weather concreting, cured on job site under same conditions as concrete it represents.

6. Compressive Strength Tests: ASTM C 39; one set for each 25 cu. yd. or fraction thereof, of each concrete class placed in any one day; one specimen tested at seven days, two specimens tested at 28 days, one held for later testing as needed.

7. When frequency of testing will provide less than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.

8. When strength of field-cure cylinders is less than 85% of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

9. Strength level of concrete will be considered satisfactory if averages of sets of two consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive by more than 500 psi.
10. Costs of any additional tests (including costs incurred by the Owner), as well as removal and reconstruction resulting from the failure to meet specified compression strength with the test cylinders, shall be borne by the Contractor. Costs for testing of concrete for replacement of defective concrete or non-conforming concrete (including costs incurred by the Owner and Architect/Engineer) shall be paid by the Contractor.

3.18 DEFECTIVE CONCRETE

A. Defective Concrete:
   1. Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
   2. Concrete which shows excessive cracking or honeycombing so much that in the opinion of the Architect/Engineer the appearance or use of structure is adversely impacted.
   3. Concrete not in conformance with compressive strength testing.

3.19 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements in this Section.

B. Drill test cores where directed by Architect/Engineer when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

E. Backfill all concrete work immediately after removal of the forms. Fill material shall be an approved earth or the required aggregate material. Place and compact all backfill material in accordance with the standards as outlined in the Division 31 Section "Earth Moving" and to the line and grade indicated on the Contract Drawings.

END OF SECTION 321313
SECTION 322000 – ATHLETIC FIELD AMENITIES

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section includes provisions for furnishing and installing all site amenities as shown on the drawings and as specified herein. The work includes, but is not necessarily limited to the following:
      1. Baseball/Softball Field Amenities
      2. Portable Bleachers

1.3 REFERENCES
   A. National Federation of State High School Associations (NFSHSA).

1.4 QUALITY ASSURANCE
   A. All site amenities shall be produced in a plant of recognized reputation that is regularly engaged in the production of the type of site amenity conforming to the specified standards. Site amenities of the same type shall be the product of a single manufacturer.
   B. Only products proven non-toxic are acceptable. Products used may not contain any recycled wood products or any wood containing paint, chemicals (including but not limited to Chromated copper arsenate (CCA)) or additives.
   C. All products supplied shall meet requirements for use per NFSHSA.

1.5 SUBMITTALS
   A. Shop drawings and manufacturer's literature including technical and installation information for each amenity specified.

1.6 DELIVERY, HANDLING, AND STORAGE
   A. Store all material so they can be easily inspected and so they will not be damaged prior to installation.
B. Materials shall be moved, loaded, and unloaded such that they will not be subject to excess stress. Permanent distortion or other damage attributable to the Contractor's operation shall be cause for rejection.

C. Materials shall be stored off the ground in a manner that will not allow distortion or other damage to occur.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate relocation and installation of site amenities with earthwork, utility installations, concrete and asphalt sidewalks, landscape plantings, topsoil spreading, and seeding.

B. Coordinate location and installation of site amenities with removals, earthwork, electrical services and associated PVC sleeving and conduits, concrete/asphalt/ paver sidewalks, landscape plantings, topsoil spreading, and other installations.

C. Excavation: When conditions detrimental to amenity installation are encountered, such as rubble fill, adverse drainage conditions, obstructions or unsuitable materials, notify the Owner’s Representative, before commencing installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers provided they provide approvable equals shall include:
   1. Sportsfield Specialties, 41155 St. Hwy 10, Delhi, NY – (607) 746-1462
   2. SportsEdge, 259 Murdock Road, Troutman, NC – (800) 334-6057
   3. Aluminum Athletic Equipment, 1000 Enterprise Dr, Royersford, PA – (800) 523-5471

2.2 BASEBALL/SOFTBALL FIELD AMENITIES

A. Provide a set of three (3) bases with anchors and anchor plugs for each field at the Intermediate School. Bases shall be 15”x15”x3” with 6” stanchions. Product Number LGBBPL – Schutt Jack Corbett MLB Hollywood Bases as manufactured by Sportsfield Specialties, Inc. or approved equal.

   1. Anchors shall be 1¾” square x 8” long female ground anchors. Product Number LGBBP – 44 – Schutt Ground Anchor Mounts as manufactured by Sportsfield Specialties, Inc. or approved equal.

   2. Additional anchors and anchor plugs shall be installed at all baseline layout locations as shown on the contract drawings.

B. Home plate shall be 1½” thick with five zinc plated mounting spikes. Product Number LGSHP – UM – Schutt Hollywood MLB Universal Pro Style Home Plate as manufactured by Sportsfield Specialties, Inc. or approved equal.
C. The pitching rubber shall be 24” long, 6” wide molded rubber construction around an aluminum cylindrical tube and designed to rotated allowing play on four sides. Product Number LGBBPB-Schutt Four Sided Professional Pitching Rubber as manufactured by Sportsfield Specialties, Inc. or approved equal.

2.3 PORTABLE BLEACHERS

A. Portable Bleachers to be 21’ long by 29 ¾” height composed of galvanized steel frames, aluminum planking and seat clips, and stainless steel hardware. Product model PB-421/ICC as manufactured by Aluminum Athletic Equipment, or approved equal. Color to be selected by owner. Quantity: 2

PART 3 - EXECUTION

3.1 GENERAL

A. Stake out location of all site amenity items and obtain approval from Owner’s Representative before installation.

B. All site amenities shall be installed in accordance with the manufacturer’s recommendations. Recommendations that are in direct conflict with the details or specifications provided in these contract documents shall be brought to the Engineer’s attention.

3.2 BASEBALL/SOFTBALL FIELD AMENITIES

A. All athletic field equipment shall be installed in accordance with manufacturer’s recommendation, at locations shown on the Contract Drawings and/or in conformance with NFSHSA requirements.

B. Portable bleachers shall be installed in accordance with manufacturer’s recommendation, and at locations shown on the Contract Drawings.

END OF SECTION 322000
SECTION 323000 - SITE AMENITIES

PART I   GENERAL

A. RELATED DOCUMENTS

1. Drawings and general Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section.

B. SUMMARY

1. This section includes provisions for furnishing and installing all site amenities as shown on the drawings and as specified herein. The work includes, but is not necessarily limited to the following:
   a. Precast Concrete Wheel Stop

C. QUALITY ASSURANCE

1. Source Quality Control:
   a. ASTM C 150 - Portland cement concrete

D. SUBMITTALS

1. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
   2. Shop drawings and manufacturer's literature including technical and installation information for all site amenity items.

E. RELATED WORK SECTIONS

1. Earth Moving: Section 312000
   2. Cast in Place Concrete: Section 033000

F. JOB CONDITIONS

1. Inspection
   a. Prior to the installation of site improvements, carefully inspect existing conditions and the installed work of all other trades. Verify that all such information and work is complete to the point where these installations may commence, without conflict.
   b. Verify that all site improvements may be installed in accordance with pertinent codes and regulations, the original design, approved shop drawings, and manufacturer's recommendations

2. Excavation: When conditions detrimental to amenity installation are encountered, such as rubble fill, adverse drainage conditions, obstructions or unsuitable materials, notify the
G. SEQUENCING AND SCHEDULING

1. Coordinate relocation and installation of site amenities with earthwork, asphalt pavement, landscape plantings, topsoil spreading, and seeding.

PART 2 PRODUCTS AND MATERIALS

A. Precast Concrete Wheel Stop
   1. Standard 6'-0” parking bumper manufactured by Kistner Concrete Products, Inc. or approved equal.
   2. Concrete shall be 4500 P.S.I. at 28 days.
   3. Entrained air shall be 5%-9%.
   4. Steel for dowels shall be ASTM A496-A615 grade 60-60 KSI.

PART 3 EXECUTION

A. GENERAL

1. Stake out location of all site amenity items and obtain approval before installation.
2. Do not proceed with installation until substrates have been prepared using the methods recommended by the manufacturer and deviations from manufacturer’s recommended tolerances are corrected. Commencement of installation constitutes acceptance of conditions.
3. If preparation is the responsibility of another installer, notify engineer in writing of deviations from manufacturer’s recommended installation tolerances and conditions.

B. MISCELLANEOUS SITE AMENITIES

1. Erect all other equipment per manufacturer's written instructions and recommendations.

END OF SECTION 323000
SECTION 323113 – SITE FENCES AND GATES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

B. Excavation for post bases.
C. Concrete anchorage for posts and center drop for gates.
D. Manual gates and related hardware.

1.2 REFERENCES

A. ANSI/ASTM A123: Zinc (hot galvanized) coatings of products fabricated from rolled, pressed, and forged steel shapes, plates, bars, and strips.
D. ASTM A120: Pipe, steel, hot-dipped zinc coated (galvanized) welded and seamless.
E. ASTM A428: Weight of coating on aluminum coated iron or steel articles.
F. ASTM A585: Aluminum coated steel barbed wire.
G. ASTM C94: Ready mix concrete.

1.3 QUALITY ASSURANCE

A. Manufacturer: company specializing in commercial quality chain link fencing with 10 years experience. Submit evidence of these projects in writing to the Architect/Engineer, including name and telephone number of person for each reference.
C. Layout Personnel: Layout of fence line shall be performed by qualified surveyors or representatives of the fence supplier.
D. All fence and gate materials and installation shall be furnished and installed by a single firm.

1.4 DEFINITIONS

A. Corner Posts: Posts located at a change in horizontal alignment.
B. End Posts: Posts located at the beginning or end of a length of fence.
C. Gateposts: Posts, which support the weight of a gate. Gateposts may function also as terminal posts but generally are sized differently.
D. Line Posts: Posts between terminal posts.
E. Pull Posts: Posts located within a length of fence at certain distances, and at changes in vertical
alignment, to facilitate stretching of fabric.

F. **Terminal Posts:** Posts set where fence fabric terminates, and between which the fabric is stretched; a term, which includes end, corner, and pull posts.

### 1.5 SUBMITTALS

A. Submit manufacture's catalog cuts and product data. Indicate post sizes, thicknesses, and materials; protective coatings (if required); fabric materials, dimensions, sizes, and characteristics; and accessories.

B. Submit color charts showing available fabric vinyl dip colors (if vinyl fabric required).

C. Submit Shop Drawings: Include plan layout, spacing of components, accessories, fittings, hardware, anchorages, and schedule of components.

1. Show overall fence layout.
2. Show location, size, material, composition, specifications, and spacing of posts, fittings, and accessories.
3. Show anchorage details.
4. Show drawings and details of all gates required.

D. Submit manufacturer's installation instructions.

E. Submit warranty/guarantee for gates.


### 1.6 WARRANTY/GUARANTEE

A. Provide Owner with written, unlimited five (5) year warranty on all fencing installations, agreeing to replace or repair any damage to any product installed as part of the work of this Section, if the product shows defects, early wear, malfunction, or other deterioration not caused by mistreatment or normal usage.

B. Warranty period to commence on the date of substantial completion of the entire project, not necessarily the date of substantial completion of the work of this Section.

C. For vinyl-dip black or other color fence fabric coating, provide additional warranty on finish coating for a period of ten (10) years, commencing on the same date as other warranties covered by the work of this Section commence.

### PART 2 - PRODUCTS

#### 2.1 CHAIN LINK FENCE MATERIALS

A. **Framework:** ASTM A120; Schedule 40 galvanized steel pipe, standard weight, one piece, without joints, galvanized.

B. **Framework:** ANSI/ASTM B429 aluminum pipe, sized in accordance with FS RR-F-191 one piece, without joints, galvanized.

C. **Fabric:** FS RR-F-191 Type I, galvanized. 1.2 oz. with vinyl coating. Fabric shall be 9 ga. Unless otherwise noted. Coordinate with design documents.
D. Where vinyl fabric required (if any), all fencing shall be as described in this section, except also provide vinyl-dipped fence fabric in black or other color selected by Owner.

E. Hinges: shall have the ability to open 180°.

F. Gate Holdbacks: All fence gates shall be equipped with No Dig Gate-Holdbacks to hold gates open in the 180-degree position.

2.2 CONCRETE MIX

A. Concrete: ASTM C94, Portland cement type 1, 4000 psi at 28 days, 3" slump, 1" sized aggregate, 6% air entrained.

2.3 COMPONENTS

A. Padlocks
   1. A padlock shall be provided for each gate installed.
   2. Cadmium rust proofed with a minimum 4 pin locking mechanism. Equip each padlock with a 9-inch chain, permanently attached to the case. All padlocks shall be keyed-alike with two (2) keys for each padlock. Provide one padlock for each gate installed. Padlocks shall be of the type, which will not permit the entrance of water and subsequent freezing in cold climates.

2.4 FINISHES - ALL MEMBERS, FABRIC, AND ACCESSORIES

A. Galvanized as per ANSI/ASTM A123, 2-ounce/square foot, 600-gram coating.

2.6 ORNAMENTAL FENCING

A. Ornamental fencing shall be Style #202 as manufactured by Jerith Manufacturing Co. or approved equal. Color shall be black.

B. Aluminum Extrusions: All posts and rails used in the fence system shall be extruded from HS-35™ aluminum alloy having a minimum yield strength of 35,000 psi. All pickets shall have a minimum yield strength of 25,000 psi. 6063-T5 and 6063-T52 Alloys (in accordance with ASTM B221) are not acceptable for any components.

C. Fasteners: All fasteners shall be stainless steel. Square drive screws shall be used to connect the pickets to the horizontal rails. Rail to post connections shall be made using self-drilling hex-head screws.

D. Accessories: Aluminum sand and die castings shall be used for all scrolls, post caps, finials, and miscellaneous hardware. Die castings shall be made from Alloy A360.0 as per ASTM B85 for superior corrosion resistance. Alloy A380.0 is not acceptable.

E. Pickets: Heavy Duty Industrial Aluminum Picket Size 1” square, 0.062” thick. Pickets are spaced 4” maximum face to face. Pickets are attached to rails at the factory using industrial drive rivets.

F. Rails: Top wall shall be 1-5/8” x 0.070” thick and side wall shall be 1-5/8” x 0.100” thick aluminum “U” channel.

G. Posts: Line posts shall be 2 1/2” square, 0.075” thick and gate posts shall be 4” square, 0.125” thick. Posts shall have a flat cap.
H. Gates: Swing gates shall match the style of the ornamental fence and as shown on contract drawings. Gates shall be equipped with adjustable hinges and lockable latches.

I. Finish:
   a. Pretreatment: A three stage non-chrome pretreatment shall be applied. The first step shall be a chemical cleaning, followed by a water rinse. The final stage shall be a dry-in-place activator which produces a uniform chemical conversion coating for superior adhesion.
   b. Coating: Fence materials shall be coated with FencCoat™, a Super-Durable TGIC polyester powder-coat finish system applied by Jerith Manufacturing LLC. Epoxy powder coatings, baked enamel or acrylic paint finishes are not acceptable. The FencCoat finish shall have a cured film thickness of at least 2.0 mils. In addition, any screw heads shall be painted to match the color of the fence.
   c. Tests: The cured FencCoat finish shall meet or exceed AAMA 2604, which includes the following requirements:
      1. Humidity resistance of 3,000 hours using ASTM D2247.
      2. Salt-spray resistance of 3,000 hours using ASTM B117.
      3. Outdoor weathering shall show no adhesion loss, checking or crazing, with only slight fade and chalk when exposed for 5 years in Florida facing south at a 45 degree angle.
   d. Finishes which only meet AAMA 2603 (or the previous version - AAMA 603) are not acceptable.
   e. Color: Standard Color – Black

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that line of fence has been properly identified.
B. Verify that encroaching fences, structures, or other items of neighbors within the property line of this parcel have been removed by others prior to the start of the work of this Section. Notify Owner and Architect/Engineer in writing immediately if encroaching elements of neighbors have not been removed. Removal of neighbors' encroaching property is not included in the scope of work of the General Construction Contract.
C. Verify that proper grade has been established.
D. Verify location of underground utilities and structures, whether new, existing to remain, existing to be removed, or existing to be relocated or altered.
E. Begin fence construction only after adequate clearance on both sides of fence is available.

3.2 INSTALLATION

A. Verify areas to receive fencing are completed to final grades and elevations. Prepare the grade and remove any surface irregularities which may cause interference with the installation of the aluminum fence.
B. Install fences and gates in accordance with the manufacturer’s instructions.
C. Gate Installation:
   1. Set gate posts plumb and level for gate openings specified in construction drawings.
   2. Install gates to allow full opening without interference after concrete has hardened around gate posts. Adjust hardware for smooth operation. Install one drop rod for double gates.

3.3 DAMAGED EXISTING FENCE

   A. Any existing fence posts designated to remain or be relocated, which becomes damaged during construction, shall be removed and replaced.

3.4 ADJUST AND CLEAN

   A. Adjust hardware for smooth operation and lubricate where necessary.

3.5 PROTECTION

   A. Protect completed work from damage. Repair or replace any damaged work. Replace items where the finish has been scratched or removed down to bare metal.

END OF SECTION 323113
SECTION 329000 - LANDSCAPE PLANTINGS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes providing all labor, materials, equipment and services to complete the landscape plantings including initial maintenance and guarantee.

B. Related Sections: The following sections contain requirements that relate to this Section.

   1. Section 312000, "Earth Moving".

1.3 QUALITY ASSURANCE

A. Landscape work to be performed by a single firm specializing in landscape work.

B. Source Quality Control:

   1. General: Ship landscape materials with certificates of inspection required by governing authorities. Comply with regulations applicable to landscape materials.

   2. Do not make substitutions. If specified landscape material is not obtainable, submit proof of non-availability to Landscape Architect, together with proposal for use of equivalent material.

   3. Analysis and Standards: Package standard products with manufacturer's certified analysis. For other materials, provide analysis by recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists, wherever applicable.

   4. Topsoil: Before delivery of topsoil, furnish Landscape Architect with written statement giving location of properties from which topsoil is to be obtained, names and addresses of owners, depth to be stripped, and crops grown during past two years.

   5. Plants: Provide plants of quantity, size, genus, species and variety shown and scheduled for landscape work and complying with recommendations and requirements of ANSI Z60.1 "American Standard for Nursery Stock". Provide healthy, vigorous stock, grown in recognized nursery in accordance with good horticultural practice and free of disease, insects, eggs, larvae and defects such as knots, sun-scald, injuries, abrasions or disfigurement.

   6. Label at least one plant of each variety with a securely attached waterproof tag...
bearing legible designation of botanical and common name.

7. Inspection: The Landscape Architect may inspect trees and shrubs either in place of growth or at site before planting, for compliance with requirements for genus, species, variety, size and quality. Landscape Architect retains right to further inspect trees and shrubs for size and condition of balls and root systems, insects, injuries and latent defects, and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from project site.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Plant and Material Certifications:

1. Certificates of inspection as required by governmental authorities.
2. Manufacturer's or vendor's certified analysis for soil amendments and fertilizer materials.
3. Label data substantiating that plants, trees, shrubs and planting materials comply with specified requirements.

C. Samples: Submit to Landscape Architect.

1. Weed barrier.
2. Topsoil (when furnished from off-site source).
3. Washed gravel / River Stone for Mow Strip
4. Mulch, as specified.
5. Steel Edging

1.5 DELIVERY, STORAGE AND HANDLING

A. Plants: Provide freshly dug plants. Do not prune prior to delivery unless otherwise approved by Landscape Architect. Do not bend or bind-tie trees or shrubs in such manner as to damage bark, break branches, or destroy natural shape. Provide protective covering during delivery. Do not drop balled and burlapped stock during delivery.

B. Deliver plants after preparations for planting have been completed and plant immediately. If planting is delayed more than six hours after delivery, set plants in shade, protect from weather and mechanical damage and keep roots moist by covering with mulch, burlap or other acceptable means of retaining moisture.

C. Do not remove container-grown stock from containers until planting time.

1.6 PROJECT CONDITIONS

A. Utilities: Determine location of underground utilities and perform work in a manner which will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.
B. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify Landscape Architect before planting.

1.7 SEQUENCING AND SCHEDULING

A. Planting Schedule: Contractor to submit proposed planting schedule, indicating dates for each type of landscape work during normal seasons for such work in area of site. Correlate with specified maintenance periods to provide maintenance from date of substantial completion. Once accepted, revise dates only as approved in writing, after documentation of reasons for delays.

B. Planting Time: Proceed with and complete landscape work as rapidly as portions of site become available, working within seasonal limitations for each kind of landscape work required.

1. Plant or install materials during normal planting seasons for each type of plant material required. Obtain Landscape Architect's approval before commencing.

2. Correlate planting with specified maintenance periods to provide maintenance from date of substantial completion.

C. Coordination with Lawns: Plant trees and shrubs after final grades are established and prior to planting of lawns, unless otherwise acceptable to Landscape Architect. If planting of trees and shrubs occurs after lawn work, protect lawn areas and promptly repair damage to lawns resulting from planting operations.

1.8 GUARANTEE PERIOD AND REPLACEMENTS

A. All plants, including relocated material shall be guaranteed by the Contractor for not less than one full year from the time of provisional acceptance.

B. At final acceptance, replace any plant that is missing, dead, not true to name or size as specified, or not in satisfactory growth, as determined by the Landscape Architect. In case of any question regarding the condition and satisfactory establishment of a rejected plant, the Landscape Architect's decision is final. Provide a guarantee for all replacement plants for at least one full growing season.

C. Replacements: Plants of the same kind and size as specified. Furnish and plant as specified herein at no additional expense to contract.

PART 2 PRODUCTS

2.1 TOPSOIL

A. Topsoil: Stockpiled for re-use in landscape work. If quantity of stockpiled topsoil is insufficient, provide additional topsoil as required to complete landscape work.
B. Topsoil shall conform to the requirements of NYSDOT Standard Specifications Section 713-01, Topsoil.

C. Provide new topsoil that is fertile, friable, natural loam, surface soil, reasonably free of subsoil, clay lumps, brush, weeds and other litter, and free of roots, stumps, stones larger than 2 inches in any dimension and other extraneous or toxic matter harmful to plant growth.

1. Obtain topsoil from local sources, naturally, well-drained sites where topsoil occurs in a depth of not less than four inches. Do not obtain from bogs or marshes.

2.2 PLANT MATERIALS

A. Plants: Conform to the varieties specified in the plant list. Plant names used in the plant list conform to "Standardized Plant Names" by the American Joint Committee on Horticultural Nomenclature. Botanical names take precedence over common names. Ensure plant material is:

1. Hardy under climatic conditions similar to those in the locality of the project.

2. Typical of their species or variety, with a normal habit of growth; sound, healthy and vigorous; well-branched and densely foliated when in leaf; free of disease, insect pests, eggs or larvae; installed with healthy, well developed root systems.

B. Sizes given on the plant list are minimum. Where a range is given, at least 50% of the plants shall be of the larger size noted.

C. Quantities shown in the plant list are given for convenience. Install all plants shown on the drawings.

D. Furnish State or Federal certificates of inspection for materials in inter-state shipments.

2.3 MISCELLANEOUS LANDSCAPE MATERIAL

A. Planting Fertilizer: Complete Fertilizer, partially organic, delivered in original unopened package bearing the following certified analysis:

10% Nitrogen
10% Phosphorus
10% Potash.

B. Bone Meal: Commercial raw bone meal, finely ground, having a minimum analysis of 4% nitrogen and 20% phosphoric acid.

C. Peat Moss: Consist of partially decomposed vegetable matter of natural occurrence, brown, clean, low in content of mineral and woody material, pH 4 to 5, granulated or shredded and free from weedy grasses, edges, rushes or mineral matter harmful to plant growth.

D. Stakes for guying trees: Sound wood of uniform size, reasonably free from knots, capable of
remaining in the ground two years, and of size shown on drawings.

E. Friction guard: Two-ply fiber bearing, rubber garden hose, not less than 1/2 inch inside diameter.

F. Wire for tree bracing and guy ing: Pliable #12 gauge, galvanized, soft steel wire.

G. Tree wrapping: First quality, heavy waterproof crepe paper manufactured for this purpose.

H. Antidesicant: Shall be Wilt-Pruf concentrate as manufactured by Wilt-Pruf, Transfilm Anti-Transpirant & Sticker as manufactured by Transfilm, Moisture-Loc as manufactured by Zorro Technology, or approved equivalent delivered in manufacturer's containers.

I. Planting mulch: 50% shredded bark and 50% medium pine bark, 2 inch to 3 inch size, uniformly mixed, free from elm or other diseased wood.

J. Weed barrier: Commercially available, ultra-violet light resistant, fiberglass mat made of 100% textile glass fiber bonded with phenol formaldehyde resin, roll type, water permeable, and a minimum of 1/4 inch and maximum of 1/2 inch thick with a density of not less than 3/4 lb. per cubic ft. Submit a sample (12" x 12") and anchors etc., along with manufacturer's information to the Landscape Architect for approval.

K. Weed Retarder: Preen Lawn Weed Control by Lebanon Seaboard Corporation, RM43 Total Vegetation Control by Ragan and Massey, Spectracide Weed Stop by Spectrum Brands Inc, or equal, delivered in manufacturer's containers and used according to manufacturer's instructions.

L. Washed River Stone Gravel: River washed gravel, clean, granular material graded from 1-1/2 inches to 2 inches in size, obtained from natural deposits and unprocessed except for removal of unacceptable sizes and materials. Wash gravel so it is free of vegetation, roots or other organic matter prior to placing. Three colors are required: 1. Off-white and tan quartz and quartzite, 2. Red ‘Medina Stone’ crushed stone or gravel, and 3. Dark grey / black. Contractor shall provide samples of stone products for approval prior to beginning work on gravel areas.

M. Watering bags shall be TreeGator as manufactured by W.A. Industries, Inc, Watering Bag as manufactured by Greenscapes, Original Slow Release Watering Bag for Trees by Yangzhou Dandelion Outdoor Equipment Co, or approved equal. for storage of up to 20 gals. Provide one bag per tree up to 4” DBH and 2 bags for trees over 4” DBH.

N. Steel Edging: Shall be 4"x 3/16" steel "Border Guard" as manufactured by Border Concepts, Inc., Commercial Grade Steel Landscape Edging by Collier Metal Specialties, Steel Edging by Sure-Loc, or approved equal, with 3/16" x 15" standard stakes at 32" OC, color: Brown. Install as per the manufacturers written instructions.
PART 3  EXECUTION

3.1 PREPARATION - GENERAL

A. Stake out individual tree and shrub locations and areas for multiple plantings. Stake locations and outline areas and secure Landscape Architect's acceptance before start of planting work. Make adjustments as may be required.

3.2 PREPARATION OF PLANTING SOIL

A. Before mixing, clean topsoil of roots, plants, sods, stones, clay lumps and other extraneous materials harmful or toxic to plant growth.

B. Mix specified soil amendments and fertilizers with topsoil at rates specified. Delay mixing of fertilizer if planting will not follow placing of planting soil within a few days.

C. Mix planting soil prior to backfilling and stockpile at site.

3.3 PREPARATION OF PLANTING BEDS

A. Loosen subgrade of planting bed areas to a minimum depth of six inches using a cultimulcher or similar equipment. Remove stones measuring over 1 1/2 inches in any dimension. Remove sticks, stones, rubbish and other extraneous matter.

B. Spread planting soil mixture to minimum depth required to meet lines, grades and elevations shown after light rolling and natural settlement. Place approximately 1/2 of total amount of planting soil required. Work into top of loosened subgrade to create a transition layer, then place remainder of the planting soil.

3.4 EXCAVATION FOR PLANTS

A. Excavate plant beds, pits and trenches with vertical sides and with bottom of excavation slightly raised at center to provide proper drainage.

B. Plant pits and beds shall be as detailed.

C. Dispose of subsoil removed from planting excavations. Do not mix with planting soil or use as backfill unless approved by Landscape Architect.

D. Fill excavations for plants with water and allow water to percolate out prior to planting.

3.5 PLANTING
A. Set balled and burlapped (B&B) stock on layer of compacted planting soil mixture, plumb and in center of pit or trench with top of ball at same elevation as adjacent finished landscape grades. Remove burlap from sides of balls; retain on bottoms. When set, place additional backfill around base and sides of ball and work each layer to settle backfill and eliminate voids and air pockets. When excavation is approximately 2/3 full, water thoroughly before placing remainder of backfill. Repeat watering until no more is absorbed. Water again after placing final layer of backfill.

B. Set bare root stock on cushion of planting soil mixture. Spread roots and carefully work backfill around roots by hand and puddle with water until backfill layers are completely saturated. Plumb before backfilling and maintain plumb while working backfill around roots and placing layers of soil mixture above roots. Set collar one inch below adjacent finish landscape grades. Spread out roots without tangling or turning up to surface. Cut injured roots clean; do not break.

C. Set container grown stock, as specified, for balled burlapped stock, except cut cans on two sides with an approved can cutter and remove.

D. Dish top of backfill to allow for mulching.

E. Place weed barrier and mulch. Replace or patch weed barrier which becomes torn or damaged. Place and anchor weed barrier per manufacturer's recommendations on the prepared plant bed site. Make holes cut to accept plants generally by cutting an "X" where plants are to be located and place the fabric over the installed tree, shrub or ground cover being careful not to crush plants. Tuck folded-back fabric around plant. Treat plant area with weed retardant in accordance with manufacturer's instructions.

F. Washed gravel: Place to depth indicated in areas shown on the drawings. Prior to placement of gravel, have weed barrier placed in accordance with manufacturer's instructions.

G. Apply antidesicant, using power spray, to provide an adequate film over trunks, branches, stems, twigs and foliage.

1. If plants are moved out of the normal planting season treat with antidesicant at nursery before moving and spray again two weeks after planting.

H. Prune, thin out and shape plants in accordance with standard horticultural practice. Prune trees to retain required height and spread. Unless otherwise directed by Landscape Architect, do not cut tree leaders and remove only injured or dead branches from flowering trees, if any. Prune shrubs to retain natural character.

I. Remove and replace excessively pruned or misformed stock resulting from improper pruning.

J. Wrap tree trunks of two-inch caliper and larger. Start at ground and cover trunk to height of
first branches and securely attach. Inspect tree trunks for injury, improper pruning and infestation and take corrective measures before wrapping.

K. Guy and stake plants immediately after planting, as detailed.

L. Provide earth "V" edging at all plant beds of shrubs and/or groundcover.

3.6 MAINTENANCE

A. Begin maintenance immediately after planting.

B. Maintain plants until final acceptance.

C. Maintain plants by pruning, cultivating, edging, remulching, fertilizing, weeding, and watering as required for healthy growth. Restore planting saucers. Water plants immediately after planting and thereafter a minimum of 2 times weekly the equivalent of 1" of rain or more often, as required by weather conditions, until acceptance. Tighten and repair stake and guy supports and reset trees and shrubs to proper grades or vertical position as required. Restore or replace damaged wrappings. Spray as required to keep trees and shrubs free of insects and disease.

3.7 CLEANUP AND PROTECTION

A. During landscape work, keep pavements clean and work area in an orderly condition.

B. Protect landscape work and materials from damage due to landscape operations, operations by other contractors and trades and trespassers. Maintain protection during installation and maintenance periods. Treat, repair or replace damaged landscape work as directed.

3.8 INSPECTION AND PROVISIONAL ACCEPTANCE

A. The Landscape Architect will inspect all work for provisional acceptance upon the written request of the Contractor received at least ten days before the anticipated date of inspection.

B. After all necessary corrective work has been completed, and maintenance instructions have been received by the Owner, Landscape Architect will certify in writing the provisional acceptance of the planting.

3.9 FINAL INSPECTION AND FINAL ACCEPTANCE

A. At the end of the guarantee period, inspection will be made by the Landscape Architect upon written request submitted by the Landscape Contractor at least ten days before the anticipated date of inspection.

B. After all necessary corrective work has been completed, the Landscape Architect will certify in writing the final acceptance of the planting.
C. Upon final acceptance, Owner will assume maintenance and protection of plants.

END OF SECTION 329000
SECTION 329200 – TURF AND GRASSES

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 describes the procedures for: Topsoil Spreading; Soil Preparation; Seeding; Mulches; Maintenance; and Warranty of lawns.

B. Lawn work includes, but is not limited to, the following:
   1. Establishment of Athletic Field turf and grasses
   2. Restoration and establishment of lawn areas.
   3. Screening, placing and spreading topsoil.
   4. Importing, placing and spreading topsoil.
   5. Sod and Seed bed preparation.
   6. Seeding and sodding athletic fields and lawns
   7. Maintenance: watering, fertilizing, mowing, core aerating and weed control.

C. Related Sections:
   1. Division 31 Section “Earth Moving”

1.3 QUALITY ASSURANCE

A. Contractor shall retain for inspection the following items:
   1. Receipts for all fertilizer, topsoil amendments and grass seed.
   2. Seed and fertilizer in unopened bags, bearing the analysis of the contents, and in sufficient quantities to meet the requirements of the project.

B. All work in conjunction with topsoil placement, seeding and establishing lawns and landscaping shall be performed under the direction of individuals experienced in the establishment of lawns and landscape plantings.

C. The Contractor is responsible for protecting the lawns and athletics fields until the areas have been turned over to the Owner. Any damage to the fields prior to the District taking ownership will be repaired and restored in accordance with the specifications by the Contractor.

1.4 BIDDER QUALIFICATIONS

A. Contractors submitting bids shall have, or include subcontractors that have, been actively and directly engaged in constructing natural athletic field systems and provide proof of ten (10) or more of such sports turf installations that have been in active use for three or more years.
In addition, the bidder shall be a member of the American Sports Builders Association or Sports Turf Manager Association. A Certified Sport Field Manager (CFB-N or CSFM) on staff for the construction of athletic fields.

1.5 WARRANTY

A. Provide a uniform stand of grass by watering, mowing, and maintaining lawn areas until final acceptance. Reseed seeded areas, which fail to provide a uniform stand of grass, with specified materials until all affected areas are accepted by the Architect/Engineer.

B. The Contractor shall employ hay or straw bale checks in all swales, at intervals not exceeding 150 lineal feet. Stake bales into grade and clean out all sediment after each storm. Reseed area disturbed by cleaning.

1.6 SUBMITTALS

A. Submit the following within 48 hours of bid opening, as requested:

1. Three (3) copies of most recent installation/reference list for all projects of similar scope to this project completed in the last three years.

2. Three (3) copies of the American Sports Builders Association or Sports Turf Manager Association certification.

B. Topographic Survey – Submit topographic survey (prepared and sealed by a licensed surveyor) to the Architect/Engineer for review and approval of the completed fine-graded competition level soccer/lacrosse field and varsity baseball field following installation of underdrainage systems and prior to beginning any seeding operations or placement of the synthetic turf field. Maximum survey grid spacing shall be 40’x40’ or closer as needed to confirm grade meets contract documents

C. Product Data: For each type of product indicated.

1. Submit seed tags from all used or partially used bags.

D. Certification of grass seed.

E. Product certificates.

F. Provide Topsoil Test Report (for Onsite and Imported Topsoil): Submit test results from Architect approved independent testing laboratory on their letterhead. Report shall:

1. Identify organic content and particle size analysis.

2. Chemical analysis testing including nitrogen, phosphorus, potassium, calcium, magnesium, cation exchange capacity, base saturation percentages, micronutrients and acidity (pH).

3. Provide timing and rates of soil additives, liming and fertilizers. (Materials and procedures regarding soil amendments and fertilizers specified in this section are general and not site specific.) Adjust all soil amendments to comply with test results based on actual soil tests and as directed by the Architect at no additional cost to the Owner.
G. Planting Schedule: Indicating anticipated planting dates for each type of planting

1.7 DELIVERY, STORAGE AND HANDLING

A. Sod:
   1. Cut, deliver and install sod within a 24-hour period. Sod cutting and shipping shall be coordinated with the sod installers.
   2. Do not harvest or transport sod when moisture content may adversely affect sod survival.
   3. Protect sod from sun, wind and dehydration prior to installation.
   4. Do not tear, stretch or drop sod during handling and installation.
   5. Store sod materials at site in an orderly manner at location(s) acceptable to the Architect.

B. Seed:
   1. Packing and Shipping: Ship seed and associated materials with certificates of inspections required by governing authorities.
   2. Do not make substitutions. If specified seed material is not obtainable, submit to the Architect proof of non-availability and a proposal for use of equivalent material with similar performance criteria as the originally specified seed material.
   3. Store all seed in the site in a cool, dry place in a manner to prevent wetting and deterioration, as approved by the Architect. Replace any seed damaged during storage as directed by the Architect.
   4. Deliver seed in supplier’s unopened packages bearing labels showing the supplier’s name and seed analysis by weight.

C. Fertilizer:
   1. Deliver fertilizer in the manufacturer’s standard sized bags showing the weight, analysis and manufacturer’s name. Store all fertilizer under a waterproof cover in a dry place as approved by the Architect.

1.8 JOB CONDITIONS

A. Contractor shall coordinate scheduling of topsoil placement, preparation of topsoil for permanent seeding, and seeding to meet the seasonal time frames.

B. Topsoil placed outside the seasonal times frames shall be temporary seeded by the Contractor, cost to be included in the price bid.

C. The Contractor is responsible to provide mechanically screened topsoil; complete fine grading; maintain topsoil and finish grade; complete preparation of topsoil; complete seeding and necessary reseeding; restore areas if eroded, settled, or otherwise disturbed after fine grading; and, provide additional topsoil and seed and restore finish grade where washout or damage occurs before grass is established.

D. The Contractor is responsible for all erosion control measures. Contractor shall provide straw bales or stoned check dams in ditches or problem swales at intervals required to adequately slow water velocity and impede soil loss.

E. Contractor shall provide mulch for temporary or winter seed and for permanent seed.
F. Lawn Topsoil Limits: All ground area within the indicated contract limit lines, or any additional area which has been disturbed in any way by the construction operations, shall be topsoiled and fine graded by the Contractor for permanent lawn seeding, unless otherwise indicated on the drawings to be covered with trees, shrubs, structure(s), walks, roads, or other surfaced areas.

G. Permanent seeding shall be placed only during the following periods as weather conditions permit:

1. Spring Seeding – Between April 1 (or thereafter when ground becomes workable) and June 1
2. Fall Seeding – Between August 15 and October 15

1.9 SEQUENCING AND SCHEDULING

A. Schedule: Prior to construction, provide a schedule which addresses the following lawn thresholds involving erosion control stabilization and competitive use of playfields:

1. Seeding and Sodding Installation: The Contractor may invoice for 50% of the approved schedule of value breakdown at the time of acceptable installation.
   a. Unless otherwise directed in writing by the Architect, seed and sod lawns from April 1 to May 15 and from August 15 to October 1. Seeding and sodding between May 16 and August 14 is not acceptable unless adequate water supply is available and applied to the turfgrass as required herein and approved by the Architect.
   b. Proceed with and complete seeding and sodding as rapidly as portions of the site become available, working within the seasonal limitations for each kind of landscape work required.

2. Substantial Completion: The Contractor may invoice for 25% of the approved schedule of value breakdown at the time of substantial completion as described in Part 3, “Standards for Substantial Completion of Lawns” of this specification section. At this time, the Architect may issue the Notice of Termination to satisfy the NYS DEC stabilization requirements. The date of substantial completion is anticipated approximately 60 days after the lawn installation presuming all Contractor maintenance operations have been vigorously performed.

3. Final Acceptance: The Contractor may invoice for the final 25% of the approved schedule of value breakdown at the time of final acceptance as described in Part 3, “Standards for Final Acceptance of Lawns” of this specification section. The date of the final acceptance is anticipated approximately 30 days after substantial completion presuming all Contractors maintenance operations have been vigorously performed.

4. Owner Maintenance: After final acceptance of the lawns, the Owner will maintain for 1 to 3 growing seasons to reach competitive maturity and beyond per ASTM F2060.

PART 2 - PRODUCTS

2.1 TOPSOIL

A. Approved and screened topsoil obtained from excavation and grading work may be used if
amended. If insufficient material (either quantity and/or quality) is available, it shall be imported. All topsoil shall be at depths indicated under Spreading Topsoil of this specification.

B. Texture and content of topsoil shall conform to the following:
   1. Soil and Texture Content:
      a. Sandy loam topsoil, well drained homogenous texture and of uniform grade, without the admixture of subsoil material. Topsoil shall be entirely free of dense material, hardpan, clay, stones over 3/4” in diameter, sod, or any other objectionable foreign material, including but not limited to, glass, debris, toxins, hazardous wastes and chemicals (such as atrazine or muriatic acid within the past seven (7) years) that may be injurious to humans, animals and plant materials.
      b. Organic Matter: Containing not less than 5% or more than 10% organic matter in that portion of a sample passing a 1/4” sieve when determined by the wet combustion method on a sample dried at 105 degrees F.
   2. pH Value: Containing a pH value within range of 6.0 to 7.0 on that portion of the sample which passes a 1/4” sieve.
   3. Sieve Analysis for general lawn work: Shall be screened or rock picked to meet the following gradation:

<table>
<thead>
<tr>
<th>Sieve Designation</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4”</td>
<td>100</td>
</tr>
<tr>
<td>1/4”</td>
<td>97-100</td>
</tr>
<tr>
<td>No. 200</td>
<td>20-65 (of the 1/4” sieve)</td>
</tr>
</tbody>
</table>

   4. Sieve Analysis for Athletic Field lawn work: Shall be mechanically screened by an onsite screening facility provided by the Contractor prior to placing and spreading. Athletic field topsoil shall meet the above sieve requirements.

C. Topsoil shall be natural, friable, fertile soil, characteristic of productive soil in the vicinity. The topsoil shall be screened and free of stones, clay lumps, roots and other foreign matter.

D. Store topsoil separately from all other excavated materials on-site and preserve for reuse or replace with imported topsoil meeting the requirements of Division 31 Section “Earth Moving”.

E. Stocked or furnished topsoil shall be tested by an approved soil-testing laboratory for determination of correct lime fertilizer additives. Submit mechanical and chemical analysis of off-site topsoil to the Architect/Engineer for approval prior to delivery of topsoil to the site. If more than one source will be used, provide an analysis of each source.

F. Topsoil Source: Imported topsoil shall meet the requirements of Division 31 Section “Earth Moving”. Import topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from agricultural land, bogs or marshes.

2.2 SEED
A. Grade A quality, fresh and recleaned and proven to produce satisfactory growth in the locality of
the project.

B. Seed Mix: Fresh, clean and from current season’s crop, delivered in original packages, unopened,
and bearing guaranteed analysis. Seed shall meet New York State standards of germination and
purity.
   1. Composed of the following varieties, mixed to the specified proportions by weight, and
tested to minimum percentages of purity and germination. Shall be free of: Poa Annua, bent
grass, and noxious weed seed such as Canadian Thistle, Coarse Fescue, European Bindweed,
Johnson Grass and leafy Spurge. The landscape contractor shall furnish to the
Architect/Engineer a signed statement certifying that the seed furnished is from a lot that
has been tested by a recognized laboratory. Seed which has become wet, moldy or in any
other way damaged in transit or storage, will not be accepted.

   2. Permanent Seed Species: Lawn Mix Rate: 5 to 6 pounds per 1,000 SF. Athletic Field Mix
   Rate: 3.5 - 4 lb per 1,000 SF. Provide certified (Blue Tag) seed of grass species and
   percentages as follows. Any substitutions must be approved by the designers.

<table>
<thead>
<tr>
<th>LAWN &amp; ATHLETIC FIELD MIX</th>
<th>Percent by Weight</th>
<th>Percent Purity</th>
<th>Percent Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Names</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd Millennium SRP Tall Fescue</td>
<td>20%</td>
<td>90%</td>
<td>87%</td>
</tr>
<tr>
<td>Rhambler SRP Tall Fescue</td>
<td>20%</td>
<td>90%</td>
<td>87%</td>
</tr>
<tr>
<td>Traverse SRP Tall Fescue</td>
<td>20%</td>
<td>90%</td>
<td>87%</td>
</tr>
<tr>
<td>Cochise IV Tall Fescue</td>
<td>20%</td>
<td>90%</td>
<td>87%</td>
</tr>
<tr>
<td>Amazing GS Perennial Ryegrass</td>
<td>10%</td>
<td>90%</td>
<td>87%</td>
</tr>
<tr>
<td>Brooklawn Kentucky Bluegrass</td>
<td>10%</td>
<td>90%</td>
<td>82%</td>
</tr>
</tbody>
</table>

C. Temporary Seed Species for Erosion Control:
   1. If spring, summer or early fall, seed with perennial ryegrass at 1 lb per 1,000 SF.
   2. If late fall or early winter, seed with Certified “Aroostook” winter rye (cereal rye) at 2.5
      lbs. per 1,000 SF.

2.3 FERTILIZER

A. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble
nitrogen, phosphorus, and potassium in the following composition:
   1. Composition: 10 percent nitrogen, 6 percent phosphorous, and 4 percent potassium, by
      weight

B. Cyanamide compounds and hydrated lime are not permitted in fertilizer mixtures.

C. Fertilizer is not required for temporary seed.

2.4 MULCH

A. Straw Mulch: Clean, mildew- and seed free oat or wheat straw well seasoned before baling, free
from mature seed bearing stalks or roots of prohibited or noxious weeds.
B. Hydro Fiber Mulch: Shall be a wood fiber or wood fiber and cellulose mixture, providing the cellulose content does not exceed 20% by volume and is thoroughly mixed with wood fiber mulch. Apply liquid tackifier uniformly at the rate of 60 gallons per acre, to keep straw mulch in place.

Examples of acceptable mulch are:
2. Conweb Hydro-Mulch 2500.
3. Mat’s Soil Guard.

2.4 WATER

A. Free of substance harmful to plant growth. Hoses, pumps, sprinklers or other methods of transportation furnished by Contractor.

2.6 SOD

A. The sod shall be machine cut at a uniform soil thickness of one half (1/2”) inch, ± one eighth (1/8”) inch, at the time of cutting. Measurement for thickness shall exclude top growth and thatch. Individual pieces of sod shall be cut to the supplier’s standard width and length. Maximum allowable deviation from standard widths and lengths shall be five (5%) percent. Broken pads and torn or uneven ends will not be acceptable. Sod shall be grown on mineral soil for 18-24 months from time of original seeding.

B. Sod shall be nursery grown and cultivated from certified seed and consisting of 95% minimum, live, vigorous plants of the following blue grasses and percentages. Sod shall contain no traces of annual blue grass, creeping bent, quack grass, nut grass, or insect pests.

C. Sod Individual pieces of sod shall be cut to the suppliers’ standard width and length. Sod grass mix shall consist of:
   27% Regenerate Tall Fescue
   23% Reflection Tall Fescue
   23% PST-5BGR Tall Fescue
   11% Navigator II Creeping Red Fescue
   9% SPF 30 Kentucky Bluegrass
   9% Shannon Kentucky Bluegrass

Any substitutions should be approved by the designers.

An acceptable substitution for sod grass mix is:
   30% Rambler SRP Tall Fescue
   25% Cochise IV Tall Fescue
   25% Monet Tall Fescue
   10% Brooklawn Kentucky Bluegrass
   10% Washington Kentucky Bluegrass

D. Sod shall be furnished and installed in rectangular sod strips measuring twelve (12”) inches or sixteen (16’’) inches in width and from four feet to six feet (4’-6’) in length, stored in rolls with the grass top side inverted so that the topsoil is to the exterior. Big roll sod will also be
E. Sod shall be well rooted, healthy, and free of diseases, nematodes, poa annua, insects, nut grass and weeds. Sod will be considered unacceptable if it contains any of the following weeds: common bermudagrass, quackgrass, johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, poa annua and bromegrass.

F. Sod shall be harvested, delivered and installed within a period of twenty four (24) hours. Soil on sod pads shall be kept moist at all times.

2.7 SEEDING ACCESSORIES

A. Weed Killer

If necessary in the opinion of the Architect/Engineer, an application of weed killer may be required prior to final acceptance. A herbicide labeled and registered in New York State for control of the target weed(s) shall be applied by a certified pesticide applicator in conformance with NY State law.

B. Mulch Tackifier

Apply liquid tackifier uniformly at the rate of 60 gallons per acre, if needed, to keep straw mulch in place.

C. Ground Limestone

Shall be applied at a rate sufficient to adjust pH to between 6.0 and 7.0 as determined by the pH testing laboratory. (Laboratory costs paid by the Contractor.) Rate of lime application not to exceed 50 pounds per 1000 sf.

1. Calcic or dolomitic ground limestone.
2. Shall contain not less than 85% of total carbonates.
3. Magnesium oxide - 10% minimum content for dolomitic and high magnesium limes.
4. Sieve Analysis - at least 50% will pass through a No. 100 mesh sieve and 90% will pass through a No. 20 mesh sieve.
5. Coarser material may be used providing the rates of application are increased as approved by the Architect/Engineer.

D. Packaging: New, clean, sealed and properly labeled bags not exceeding 100 pounds each.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that all underground and above ground work has been completed to the point where topsoiling, fertilizing, seeding and mulching operations may properly commence without unnecessary disturbances at a later date.
3.2 SPREADING TOPSOIL

A. In lawn areas to be seeded, provide topsoil to a minimum compacted thickness of 4-inches. In athletic field areas to be seeded, provide topsoil to a minimum compacted thickness of 6-inches. In the event that insufficient topsoil is not available from stripping the area to be excavated, the Contractor shall import enough additional topsoil to make up the deficit at no additional cost to the Owner.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4-inches to facilitate bonding of the topsoil to the subgrade. Use discs, spike-toothed harrows or other approved means. Clean surface of subgrade of all stones larger than 1-inch in any dimension and all sticks, roots, rubbish, and other extraneous matter and legally dispose of them offsite.

1. Thoroughly blend planting soil mix off-site before spreading, or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.
2. Spread planting soil mix, evenly on the approved prepared subgrade, to a depth of 4 inches on lawns and 6-inches on athletic fields but not less than required to meet finish grades after light rolling and natural settlement.

C. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
   a. Apply slow release fertilizer directly to surface soil before loosening at a rate equal to 1.0 pound of actual nitrogen per 1,000 square feet (430 pounds of fertilizer per acre).
3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including grass, vegetation, and turf, offsite.

D. Carry out spreading so that turfing operations can proceed with a minimum of soil preparation or tilling. Do not spread topsoil when the ground is frozen, excessively wet or otherwise in a condition detrimental to the work in conformance with all legal requirements and in a manner acceptable to the Architect/Engineer.

E. Finished Grades: Shall be understood to be final spot grades and contours indicated on the contract drawings. Where final spot grades or new contours are not indicated, finished grades shall be uniformly level or sloping between points for which elevations are given or contours are shown or shall be graded to the elevations which previously existed. However, final surface grades shall afford positive drainage of all areas at all times.

F. Tops and Bottoms of All Slopes: Round tops and bottoms of slopes and drainage swales. Adjust and warp slopes, at intersections of cuts and fills, to flow into each other or into the existing natural ground surface without noticeable break. Cuts and fills shall have a maximum slope of 3-foot
horizontally to 1-foot vertically, unless otherwise shown on the contract drawings.

G. Fine Grading Lawn Areas: Bring the grade of areas to receive lawns to a uniform, level slope, as determined by the use of surveying instruments, by discing, harrowing and other methods approved by the Architect/Engineer. Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture.

When establishing finish grades, remove and dispose of all clods, hard lumps, stones and rocks, roots, litter and other foreign matter not passing through the teeth of a hand iron rake. Tractor drawn raking equipment that compacts lawn areas will not be allowed. Dispose of all such materials off-site.

H. Remove all topsoil spilled on highways, shoulders, sidewalks, driveways and other surfaces for which topsoil is not specified or required.

I. Settlement: Maintain ground surfaces to the finish grades shown on the contract drawings, and deposit whatever additional topsoil that may be required to correct any settlement or erosion that occurs prior to the date of issuance of the Certificate of Final Acceptance. The surface upon which additional topsoil is to be deposited shall be raked or otherwise satisfactorily prepared to ensure a proper bond. Fill hollows that develop from settling, to the finished elevations, with approved topsoil. Finished lawn areas shall be left sufficiently high to meet all paved areas and catch basins after settlement.

3.3 PREPARATION OF TOPSOIL

A. For preparation and amending topsoil in athletic field areas, see Athletic Field Preparation Specification.

B. If the following conditions exist at the time of sowing seed, placing fertilizer and lime, this paragraph may be omitted:
   1. Topsoil has been spread and raked clean within the past 10 days and is shaped to the required grade.
   2. Topsoil was spread more than 10 days ago but the top 3-inches is loose, friable, reasonably free from large clods, rocks, large roots, or other undesirable matter and shaped to the required grade.

C. If any of the above conditions do not exist, then prepare the topsoil in accordance with the following paragraphs.

D. Repair all eroded and damaged surfaces, cut or otherwise remove all weeds and grass and scarify or otherwise loosen topsoil to a depth of not less than 3 inches.

E. Break up large, stiff clods, and hard lumps, and rake off all stones and rocks larger than 1-inch in size, roots, litter, foreign matter, poisonous materials, and other materials, which may be detrimental to the work. Dispose of all such materials off-site in conformance with all legal requirements and in a manner acceptable to the Architect/Engineer.

F. Liming (used when required to adjust pH of topsoil):
1. Apply separately at a rate sufficient to bring the pH of the topsoil between 6.0 and 7.0 as determined by the pH-testing lab, prior to fertilizing, seeding and sodding. Lime may be applied dry by spreader or as an aqueous solution by spraying. Rate of lime application not to exceed 50 lbs per 1000 sf.

2. After application, work lime into the top 3-inches of topsoil and redress surface to a smooth finish.

3.4 SEEDING LAWNS AREAS

A. Seeding Limits: All ground area within the indicated contract limit lines, or any additional area which has been disturbed in any way by the construction operations, shall be fine graded and planted with lawn seed mix unless otherwise indicated on the drawings to be covered with trees, shrubs, structure(s), walks, roads, or other surfaced areas.

B. Responsibility: The Contractor shall utilize all such measures as may be necessary, including, but not limited to, protective fencing, sod, or erosion control netting to produce a finished continuous blanket of turf over all areas designated to receive lawns.

C. Fertilizer (Dry)
   1. Apply fertilizer to indicated lawn areas at a rate equal to 1.0 pound of actual nitrogen per 1,000 square feet (430 pounds of fertilizer per acre).
   2. Apply fertilizers by mechanical rotary or drop type distributor, thoroughly and evenly incorporated into soil to a depth of 3-inches, by discing or other approved method. Fertilize areas inaccessible to power equipment with hand tools and incorporate into soil.
   3. Restore prepared areas to specified condition if eroded, settled, or otherwise disturbed, after fine grading and prior to seeding.

D. Seeding Operations (Lawns Only)
   1. Dry Seeding
      a. Seed immediately after preparation of bed and meeting seasonal time frames.
      b. Seed indicated areas, within contract limits and areas adjoining contract limits, disturbed as a result of construction operations.
      c. Perform seeding operations when the soil is dry and when winds do not exceed 5 miles per hour velocity.
      d. Apply seed with a rotary or drop type distributor. Install seed evenly by sowing equal quantities in two directions, at right angles to each other.
      e. Sow grass seed at rate recommended by seed vendor and approved by the Architect/Engineer. The total rate of seed application shall be based upon "new lawn" requirements and shall not be less than 5 pounds per 1,000 square feet.
      f. After seeding, lightly rake or drag surface of soil to incorporate seed into top 1/8-inch of soil. Roll with light lawn roller.

E. Fertilizing and Seeding (Wet-Hydro Seeding)
   1. Hydro seeding is not allowed on Athletic Field Lawns.
   2. Contractor may apply seed and fertilizer by spraying them in the form of an aqueous mixture. Water used shall be fresh water free from injurious chemicals and other toxic substances harmful to plant life.
   3. Equipment shall be of a type made specifically for this purpose and capable of maintaining a uniform mixture, even when not spraying. Use a hydromulcher (sprayer).
4. Apply mixture(s) at the following rates. Mix in accordance with manufacturer's recommendations. Protect all paving, buildings, plantings and all nonseeded areas from over spraying of hydroseed mixture. Contractor shall clean up unwanted deposits at his expense.

**LAWN SEED**

a. Grass Seed: 200 to 250 pounds/acre.
b. Fertilizer: At rate necessary to provide 1lb actual nitrogen per 1,000 SF.
c. Tackifier: 60 gallons/acre.
d. Wood Cellulose Fiber Mulch: 2,000 pounds/acre.

5. Roll seeded surfaces if mulch is not used and only after soil has dried. Roll with light lawn roller.

6. A non-harmful color additive, which colors the hydroseed mixture green, shall be added to the mixture to allow visual metering of its application. The hydroseed mixture shall be sprayed upgrade and uniformly on the surface of the soil to form an absorbent cover, allowing percolation of water to the underlying soil.

**F. Mulching of Lawn Areas (Lawns Only)**

1. Place straw mulch on seeded areas within 24 hours after seeding.
2. Place straw mulch uniformly, in a continuous blanket, at the rate of 2-1/2 tons per acre or two 50-pound bales per 1,000 square feet of area. A mechanical blower may be used for straw mulch application, when acceptable to the Architect/Engineer.
3. Anchor straw mulch with liquid tackifier, applied uniformly at a rate of 60 gallons per acre.
4. Protect all paving, buildings, plantings and all nonseeded areas from liquid tackifier over-spray.
5. Provide straw bales checking in ditches or problem swales at intervals required to adequately slow water velocity and impede soil loss.

**3.5 SOD INSTALLATION**

**A.** Care shall be taken to eliminate depressions or air pockets by rolling or tamping base before installation. The soil shall be moistened prior to laying the sod.

**B.** The sod shall be laid smoothly, edge to edge, and where continuous or solid sodding is called for on the plans sod shall be laid with the longest dimension parallel to the contours. Vertical joints between sods shall be staggered. Immediately after laying, sod shall be pressed firmly into contact with the sod bed by light rolling, or by other approved methods so as to eliminate all air pockets, provide true and even surfaces, insure knitting and protect all exposed sod edges, but without displacement of the sod or deformation of the sod surface. Sod shall be laid with all joints compressed and at no time will shrinkage leave greater than 1/8” gap.

**C.** Sod may be placed from April 15th to November 1st as long as the ground is not frozen.

**D.** Sod shall be harvested, delivered and transplanted within a period of twenty four (24) hours.

**E.** Sod shall be watered immediately during and after installation to prevent drying. It shall then be thoroughly irrigated to a depth sufficient that the underside of the new sod pad, and soil immediately below the pad, is thoroughly wet.
F. Any sod on slopes 4 to 1 or greater will be securely fastened to the base by wooden pegs or an acceptable substitute.

G. 24 hours after installation, the sod shall be hand rolled by approved methods.

H. Repair joint separations. Dead or washed out sod will be replaced with sod similar to the original installation. The turf bed will also be repaired as is necessary before replacement sod is laid.

3.6 MAINTENANCE FOR PERMANENT LAWN AREAS

A. Maintenance by Contractor begins as soon as lawns are sodded or seeded. Protect lawns from drought, washout and wind erosion. In general, maintain new installed lawn areas, including watering, fertilizing, core aerating, spot weeding, overseeding, mowing applications of herbicides, fungicides, insecticides, and re-sodding until a full, uniform, healthy, vigorous stand of grass free of weed, undesirable grass species, disease, and insects is achieved and accepted by the Architect. Specifically:

1. Watering Seeded Lawns:
   a. First Week: In the absence of adequate rainfall, watering shall be performed daily or as often as necessary during the first week to maintain moist soil to promptly germinate the lawn seed, preventing it from drying out, and keeping it in a healthy, growing condition until final acceptance. Lawn areas shall receive a minimum of (1") of water per week, by natural rainfall, irrigation or a combination of both. Water daily until 2nd mowing (just enough water to keep the top1/2" of soil moist, 1 time daily).

2. Watering Sodded Lawns:
   a. First Week: Soil on sod pads shall be kept moist. In the absence of adequate rainfall, watering shall be performed daily or as often as necessary during the first week and in insufficient quantities to maintain moist soil to a depth of at least (4") inches.

3. Second and Subsequent Weeks: Contractor shall provide water to the lawns as required to maintain adequate moisture, in the upper four (4") inches of soil, necessary for the promotion of deep root growth until final acceptance. After 2nd mowing, water two (2) times weekly until thoroughly established.

4. Protect: Protect lawn areas against trespass, vandalism and routine pedestrian traffic and Owner maintenance traffic by temporary fencing or other means.

5. Repair: Repair, rework, resod, and overseed (as originally specified for that area) areas that have washed out, eroded, do not germinate and are vandalized or otherwise damaged. Overseeding rates are to be adjusted to 6lbs. of seed per 1,000 s.f.

6. Mow: Initial mowing shall begin when the blade height reaches 2” and the soil will bear the weight of the lawn mower. Use mowers with low impact tires. For the first 3 mowings cut the grass blades to 1.5 inches. After that mow the grass when it reaches a height of 3.5” to a height of about 2.5”. Never remove more than 1/3 of the grass blade at any one mowing. A minimum of eight (8) to ten (10) mowings are required (approximately once per week after the initial germination period to final acceptance).
Notify the Architect of dates in wiring as mowing is performed. Excess clippings shall be carefully raked so as not to remove healthy grasses, and removed.

7. Core aerating on Lawn Type 3 and 4 Only: Between mowings five (5) and six (6), core aerate lawns about three (3") inches on center minimum three (3") inches deep to ensure aggressive root growth. This will required multiple passes at different directions to achieve 16 to 20 holes ¾” to 1” diameter per square foot. Sweep scattered plugs off paved areas onto adjacent lawn areas. Pulverize plugs during subsequent mowing operations. Provide additional core aerating as directed by the Architect to expedite the lawn maturation process. Moisten field by thoroughly watering the topsoil profile, several days in advance of coring to facilitate proper penetration of the topsoil.

8. Fertilizer: Immediately after core aerating, apply subsequent fertilizer at the rate of 1.5-2 lbs./1,000 sf. Provide additional fertilizer after the 10th mowing as directed by the Architect to expedite the lawn maturation process.

9. Weed Control: When infestation of weeds or crabgrass develops, treat infestation by hand weeding or herbicides control appropriate to the area. Furnish and install weed chemical control as recommended by manufacturer. Herbicides controls must be acceptable to the Owner. Obtain and pay for permits. Use as directed by the manufacturer and applicable laws, codes, ordinances and regulatory requirements. Under NO circumstances is it acceptable to seed or overseed over Nutsedge, Crabgrass or other grassy/broadleaf weeds.

B. Maintenance by the Contractor continues through the certificate of substantial completion final acceptance by the Architect as described below. Maintenance by Owner begins after final acceptance of the lawn.

3.7 MAINTENANCE FOR TEMPORARY LAWN AREAS

A. Contractor shall roll, regrade, re-topsoil and reseed, washed out, eroded, settled or damaged areas as required.

B. Contractor shall establish and maintain temporary lawn by seeding, watering, reseeding, and other operations.

C. Mowing of temporary seeded areas for erosion control is not required.

3.8 SUBSTANTIAL COMPLETION

A. Review to determine substantial completion of lawns will be made by the Architect, upon request. Provide notification at least five (5) working days before requested review date.

B. Lawn areas will be substantially complete provided requirements, including maintenance, have been complied with. A healthy, vigorous, uniform, partially mature stand of lawn is established free of weeds, undesirable grass species, disease, and insects. With proper watering and maintenance as indicated herein, this should culminate after an approximate 60-72 day period for initial germination with average temperatures above 40°F. Grass roots shall have matured to a minimum of 1 1/2” depth as determined by the Architect when core samples are taken.
C. Lawn areas shall not have more than 10% dead/bare spots.

D. Contractor shall provide a written copy of all maintenance activities performed up to this date.

E. The Architect will prepare a written punch list of items which need correction prior to final acceptance.

3.9 FINAL ACCEPTANCE

A. Review to determine final acceptance of lawns will be made by Architect, upon request. Provide notification at least five (5) working days before requested review date.

B. Lawn areas will be acceptable provided requirements, including maintenance, have been complied with. A healthy, vigorous, uniform, full stand of lawn is established free of weeds, undesirable grass species, disease, and insects. Grass roots shall have matured to a minimum of 2” depth as determined by the Architect when core samples are taken.

C. Any lawn which contains disease, more than 1% dead/bare spots, or any dead/bare area greater than one (1) square foot shall be rejected and the unacceptable area(s) repaired as originally specified at no additional cost to the Owner.

D. In the event the Contractor fails to complete the punch list items within a 30 day period with average temperatures of 40°F after the time of Substantial Completion, the Contractor shall be liable to the Owner for any additional costs including those charged by the Architect.

E. Contractor shall provide a written copy of all maintenance activities performed during the contract up to final acceptance of lawns.

END OF SECTION 329200

TURF AND GRASSES
SECTION 329219 – INFIELD MIX

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. Supply and install new infield mix as indicated on Contract Drawings.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 INFIELD MATERIALS

A. Sand – The sand layer shall be installed below the infield mix and shall meet the following sieve analysis:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>#4</td>
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<tr>
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<td>#50</td>
<td>20-30%</td>
</tr>
<tr>
<td>#100</td>
<td>2-15%</td>
</tr>
<tr>
<td>#200</td>
<td>0-2%</td>
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</tbody>
</table>

B. Infield Mix – Softball infield mix shall be Marco Clay Erie Ball Mix, or approved equal. The infield mix shall have a uniform, consistent medium, providing a safe playing surface, dependable bounce and good playability. This material shall also be used in the warning track.

C. The infield mix shall meet the following requirements:
   1. Soil Classification: 65-75% Sand, 12-24% Silt, 10-15% Clay
   2. Weight: Approximately 2,650 LB/CY
   3. Sieve Analysis:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>#4</td>
<td>100%</td>
</tr>
<tr>
<td>#7</td>
<td>70-85%</td>
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<tr>
<td>#20</td>
<td>55-75%</td>
</tr>
<tr>
<td>#60</td>
<td>45-55%</td>
</tr>
<tr>
<td>#140</td>
<td>35-45%</td>
</tr>
<tr>
<td>#200</td>
<td>25-40%</td>
</tr>
</tbody>
</table>
PART 3 - EXECUTION

3.1 INFIELD MIX

A. Infield area shall be boxed out to a depth of six (6) inches below the final grade, graded smoothly to pitch away from the pitcher’s mound toward the outfield and foul lines or as otherwise indicated on the grading plan. Subgrade shall be compacted, with any cobbles or boulders or any other unsuitable materials removed from the infield area.

B. Place three (3) inches of sand, installed and compacted per infield mix manufacturer’s recommendations.

C. Place three (3) inches of infield mix, installed and compacted per manufacturer’s recommendations.

D. After installation, infield shall have a maximum uniform slope of 1% toward the outfield. Any low spots shall be filled with additional mix, and rolled per manufacturer’s recommendations.

END OF SECTION 329219
SECTION 330513 - PRECAST MANHOLES

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. Furnishing and installing complete, all storm and sanitary precast manholes with frames, grates, covers, steps, inverts, and testing at the locations shown on the plans or as directed by the Architect/Engineer.
B. Adjustment of existing manholes and frames and covers/grates to grade with brick or rings.
C. Shallow manholes shall be used wherever depth of manhole is less than minimum for a precast base.
D. Related Sections:
   1. Division 33 Section “Site Water Utility Sewer Systems”
   2. Division 31 Section “Earth Moving”
   3. Division 32 Section “Turf and Grasses”
   4. Division 33 Section “Storm Utility Drainage Piping”

1.3 QUALITY ASSURANCE
A. All precast concrete sections and structures, and all castings shall each be the product of a single manufacturer who can furnish evidence of satisfactory experience in the product of high quality products of the type indicated and specified.
B. All structures and castings shall be of good quality and free from defects which would make it unfit for the use intended.

1.4 SUBMITTALS
A. Submit manufacturer’s data shop drawings for precast base, riser, and precast tops, steps, frames and cover, grates, coatings, pipe connectors, etc.
B. Submit manufacturer’s certification of compliance for precast concrete sections and castings.

1.5 PRODUCT HANDLING
A. All material shall be delivered to the job site intact and in good condition.
B. Carefully handle precast sections and all castings when loading and unloading to avoid damage.

C. In the event of damage, either in delivery or installation, the damaged section shall be immediately removed from the project site and replaced at no additional cost to the Owner.

PART 2 – MATERIALS

2.1 PRECAST CIRCULAR MANHOLE SECTIONS

A. Precast grade rings, riser bases, and risers shall be circular in cross section and precast tops shall be flat slab. Eccentric cone type tops may be used where the inside height dimension from the bench wall to the bottom of the eccentric section exceeds eight (8) feet. The flat slab shall be reinforced to withstand AASHTO H2O-44 concentrated wheel loading and 30 percent impact loading. An opening matching the casting frame inside base diameter shall be eccentrically located in the flat roof slab.

B. All precast sections shall conform to ASTM C-478 construction and minimum dimension criteria. Riser sections shall be of maximum practicable length to attain the specified grade elevation with the minimum number of joints and the shortest possible chimney.

C. All concrete shall be made with Type II Portland Cement.

D. Precast reinforced bases shall be integrally cast with wall riser conforming to ASTM C-478 with a minimum 3500 psi concrete.

E. Openings in precast riser sections to receive pipes shall be accurately cast, both vertically and circumferentially. Where openings are incorrectly cast, the riser section shall be removed from the project site and replaced with a satisfactory base. Costs for replacements, whether attributed to improper manufacturing, field changes, or for any other reason shall be borne by the Contractor.

F. Provide adequate lifting anchors on each precast section. Lifting holes shall not be allowed.

G. Precast sections for sanitary and storm manholes shall be manufacturer coated as follows: two coats (12 mils minimum per coat) of Sikaguard 62 by Sika or Duralkote 240 by Euclid Chemical Company or approved equal for interior coating of base to top of highest pipe, two coats (12 mils minimum per coat) of Conseal CS-55 or approved equal on other interior and all exterior surfaces. All coating shall be completed in accordance with the paint manufacturer’s instructions.

2.2 PRECAST MANHOLE JOINTS

A. Joints shall be formed with male and female ends so that when assembled, a continuous and uniform manhole without appreciable irregularities in interior wall surfaces will be completed.

B. O-ring seals shall conform to ASTM C-443.

C. Permissible variations are as follows:
1. Internal dimensions – not more than 1 percent
2. Wall thickness – not more that 5 percent or $\pm \frac{3}{16}$ inch, whichever is greater
3. Length of two opposite sides – not more than 5/8 inch
4. Length of section – not more than 1/2 inch in any one section

D. Seal all manhole section joints with flexible joint sealant, which shall be “Kent Seal No. 2” by Hamilton-Kent, Butyl-Tite by Blue Ridge Rubber Company or approved equal.

2.3 MANHOLE STEPS

A. Manhole steps where required shall be installed by the precast manhole manufacturer and integrally cast into the precast riser sections.

B. Manhole steps shall be designed for a concentrated live load of 300 pounds. The steps shall be manufactured of a material, which is resistant to highly corrosive conditions.

C. Steps in riser and conical sections shall be aligned in each section so as to form a continuous ladder with runs equally spaced vertically in the assembled manhole at a maximum distance of 12 inches apart. The lowest rung shall be within 18 inches of solid footing (e.g., structure bench) upon which the person descending the rungs would normally step. The uppermost rung shall be set within 18 inches of the rim of the structure frame to act as a handhold. If this rung must be set in the brick chimney, it shall set so as to extend 3 inches from the face of the brick to facilitate easy passage. Make every effort to locate rungs on a wall with no pipe penetrations.

D. Steps shall be embedded in the wall sections a minimum of 3 inches and project a minimum clear distance of 4 inches from the points of embedment.

E. The minimum centerline width of rungs shall be 13 inches.

F. The steps shall be constructed of a minimum 1/2 inch grade 60 steel reinforcement imbedded in copolymer polypropylene plastic.

G. Steps shall be as manufactured by M.A. Industries Inc. PS2-PF or approved equal.

2.4 BRICK

A. Brick shall be first quality sound, hard-burned, common brick conforming to ASTM Standard C-32, Grade SS. Brick shall be culled of all irregulars and unsound or damaged brick before laying.

2.5 MORTAR

A. Mortar shall consist of one part Portland Cement to two parts sharp, clean masonry sand to which hydrated lime may be added in the proportion of 10 pounds for each bag of cement. Mortar materials shall conform to the following:

<table>
<thead>
<tr>
<th>Material</th>
<th>ASTM Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland Cement</td>
<td>C-150 Type I or II</td>
</tr>
<tr>
<td>Sand Aggregate</td>
<td>C-144</td>
</tr>
</tbody>
</table>
2.6 HYDRAULIC CEMENT

“Sikaplug” by Sika Chemical Corp., “Waterplug” by Standard Dry Wall Products, Inc., or approved equal.

2.7 MANHOLE COVERS, GRATES, AND FRAMES

A. All manhole frames, grates, and covers shall be iron castings conforming to ASTM A48, Class 30. They shall be true to pattern in form and dimensions, without unfiled angles or corners; and shall be free from pouring faults, sponginess, cracks, blowholes, shrinkage, distortion and other defects. After casting and prior to shipping, smooth and clean all surfaces by sand blasting. Castings shall be factory coated with coal tar pitch varnish. Castings shall be thoroughly shop coated with one coat of Conseal CS-55 or coal tar enamel or asphalt base bituminous material with a minimum dry thickness of 12 mils.

B. Frames and covers shall be accurately made and covers shall fit in any position without rocking. Horizontal and vertical fitting surfaces shall be milled to true and even surface to insure uniform bearing.

C. All frames, grates, and covers must conform to these specifications as to quality, strength, thickness of metal and finish. Covers shall be furnished with lettering on face where required and as shown on the contract drawings. All castings shall be designed to sustain AASHTO H20-44 wheel loading. The minimum thickness of metal at any point shall be 3/4 inch.

D. Fabricate all frames, grates, and covers so that covers and grates fit in any position without rocking. Mill horizontal fitting surfaces to a true and even surface to insure uniform bearing. Units and portions of units shall be interchangeable.

E. SANITARY COVER: All sanitary manhole covers shall be solid and provide a non-penetrating pick hole for lifting. The covers shall have a non-skid surface and shall have raised lettering of two inches or more in size (cast into the cover). On the covers, the following shall be clearly printed: “SANITARY”. The minimum clear opening of the frame shall be 24 inches. Acceptable frame and cover shall be Neenah R-1556, Syracuse Casting 1009-8C, or approved equal.

F. HINGED WATERTIGHT FRAME AND COVER: Provide hinged solid cover with non-penetrating pickhole. Provide cover with a non-skid surface, raised lettering of two inches or more in size (cast into the cover). On the covers, the following must be printed: “SANITARY”. The minimum clear opening of the frame must be 24 inches. Locking cover must have rubber watertight gasket, cam lock, and lift assist strut that reduces the lifting force of the cover to less than 35 lbs. Opening range of the cover must be 120 degrees minimum. Provide East Jordan Iron Works 104032L01 cover or approved equal.

G. SOLID STORM COVERS: All solid storm manhole covers shall have a non-skid surface and shall have raised lettering of two inches or more in size (cast into the cover). On the covers the
following shall be clearly printed: “STORM”. The minimum clear opening of the frame shall be 24 inches. Acceptable frame and cover shall be Neenah R-1556, Syracuse Casting 1009-8C, or approved equal. Where indicated on the Contract Drawings the minimum clear opening of the frame shall be 30 inches. Acceptable frame and cover for 30-inch clear openings shall be Syracuse Casting 1016A, or approved equal.

H. STORM ROUND INLET COVER: All storm inlet manholes where shown on the contract drawings shall be provided with inlet covers with openings for entrance of surface water. The inlet covers shall be of the flat grate type, bicycle proof with a 24-inch minimum clear opening of the frame. Acceptable frame and cover shall be Neenah R-2556-A or approved equal.

2.8 SANITARY PIPE CONNECTIONS TO NEW MANHOLES
A. A gasket shall be cast into the manhole wall for sanitary manholes to assure a watertight connection with the attached pipe. The gasket shall meet the requirements of ASTM C-923.
B. Gasket shall be “A-Lok” by A-Lok, Inc., of Trenton, New Jersey, Star Seal by Hail Mary Rubber Company, or approved equal.

2.9 SANITARY PIPE CONNECTIONS TO EXISTING MANHOLES
A. Provide an approved flexible and watertight connection at the wall. Acceptable product shall be Model S Link-Seal of the appropriate size for the pipe material or approved equal. For sanitary use the seal component shall be EPDM rubber with stainless steel bolts and nuts.

2.10 CONCRETE BENCH WALLS
Concrete for bench walls and inverts shall be:

1. Normal Weight Concrete – Type A
   a. Minimum compressive strength f’c: 3,000 psi @ 28 days.
   b. Maximum water-cement ratio by weight: 0.50.
   c. Minimum cement content: 475 lbs. per cubic yard.
   d. Coarse aggregate size: 1 inch.
   e. Maximum slump: 3-1/2 inches ± 1 inch.
   f. Air Content: 4-6 percent ± 1 percent by volume of total mix.

2.11 PRECAST DOGHOUSE MANHOLE (if required)
A. Provide cast-in-place slab to accommodate the actual manhole base provided and a minimum of 12-inch of clear for an extended foot.
B. Provide continuous waterstop between riser and interior concrete fill.
C. Provide minimum manhole base diameter as shown on the Plans. Provide minimum riser section of 4 feet in diameter. Refer to Plans for additional details.
2.12 ADJUSTMENT OF RIM

A. Precast grade rings shall conform to ASTM C-478 construction and minimum dimension criteria. All concrete shall be made with Type II Portland Cement.

B. Brick shall be first quality sound, hard-burned, common brick conforming to ASTM Standard C-32, Grade SS. Brick shall be culled of all irregulars and unsound or damaged brick before laying.

C. Mortar shall consist of one part Portland Cement to two parts sharp, clean masonry sand to which hydrated lime may be added in the proportion of 10 pounds for each bag of cement. Mortar materials shall conform to the following:

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<td>C-144</td>
</tr>
<tr>
<td>Hydrated Lime</td>
<td>C-207</td>
</tr>
</tbody>
</table>

D. Hydraulic Cement shall be “Sikaplug” by Sika Chemical Corp., “Waterplug” by Standard Dry Wall Products, Inc., or approved equal.

2.13 ALUMINUM STOP LOGS

A. All material must be provided by single manufacturer to ensure compatibility.

B. Provide four (4) 6" high aluminum log planks manufactured by Rodney Hunt or approved equal.

C. Provide stop log planks, lifting lugs, and appurtenances conforming to the requirements of ASTM B308 and to aluminum alloy and temper AA-6061-T6. Provide a mill finish.

D. Provide lip type seals extruding neoprene conforming to ASTM D2000, durometer 60±5.

E. Provide type 304 stainless steel guides, anchor bolts, and miscellaneous hardware and lifting devices conforming to ASTM A276.

F. Provide 8’ long lifting hook

PART 3 – EXECUTION

3.1 GENERAL

A. It is the intent of this specification to secure soundly constructed, watertight manholes constructed in accordance with the Contact Drawings.

B. Verify that excavation is in the proper location, that pipes have been installed at the correct elevations and that the subgrade has been properly prepared. Foundations shall not be placed upon frozen or muddy subgrade.
3.2 ORIENTATION OF COVERS, GRATES, AND RUNGS

A. General – The intent of this paragraph is to provide guidance in the selection of the location of the frame and cover. The location should provide for convenient ingress and egress, and minimizes adverse visual impacts. Unless otherwise specified, shown on the Drawings, or directed by the Architect/Engineer, orient the location of covers and steps by using the following criteria, with precedence given in the order presented.

C. Safety – Give primary concern to safety considerations for providing convenient access to structure interiors.

D. Covers and Pavements – To avoid future problems with snow removal or street cleaning, orient covers to lie completely outside of paved surfaces, including walks and roadways. If this cannot be accomplished, locate covers completely in pavement. Covers partially in pavement are not permitted without the prior approval of the Architect/Engineer. When covers occur in paved areas, locate entirely within a single traffic lane and as near to the edge of pavement as is possible, but no closer than 8 inches from the edge of pavement.

E. Ingress/Egress – Coupled with the above, convenient and safe access to within the structure must be evaluated. Coordinate cover location with pipe openings, structure benches and inverts, safety landings and the like. Make every effort to locate steps on a wall with no pipe penetrations and, where steps are not specified to be provided, consideration shall be given to the safest means of seating the feet of ladders which will be used for access to structure interiors.

F. Non-compliance – Non-compliance with the requirements of this paragraph may result in Architect’s/Engineer’s disapproval of the entire structure. When requested, Architect/Engineer will assist in determining the optimum location of covers, grates, and rungs.

3.3 INSTALLATION OF PRECAST MANHOLES AND STRUCTURES

A. Precast Bases: Place stone bedding, level, and tamp firmly in place. When absolutely necessary, pea stone may be used for minor grade adjustments in the stone bedding, but the depth shall not exceed 3/4 inch. Carefully lower precast base in place, taking extra care not to shift the stone bedding, and align all openings with the pipes to be connected. Leveling of the base by tamping or pounding on the top of the precast product is prohibited. If base is not level, lift it out; readjust stone bedding, and reset base. Continue this procedure until base is level.

B. Precast Risers and Top Sections: Thoroughly clean all joints of precast sections and install jointing material. Carefully set precast sections in place, making sure that rubber gasket jointing material is not displaced and that a good seal is attained.

C. Filling Precast Section Joints: Fill interior and exterior joints with flexible joint sealer. Cover inside and outside of joint with two coats of Conseal CS-55 coal tar, or approved equal.

D. Inverts:

1. Inverts shall be constructed in all manholes.
2. Pipe entering or leaving the manhole shall be placed in openings with flexible connections (neoprene boot) provided in precast shell at the proper invert elevation.

3. For bases with preformed openings pipes entering or leaving the manhole shall be placed in preformed openings provided in the precast wall at the proper invert elevation and grouted into place with non-shrink grout. (For PVC pipes use 100 percent epoxy non-shrink grout).

4. Inverts built upon precast base shall be constructed of concrete brick, half sections of sewer pipe or be cast in place. Care shall be exercised in forming inverts to give proper slope and shape to each channel. Inverts shall be the depth of the pipe.

5. When PVC material is used, all brick, concrete, or other masonry material that interfaces with the PVC, shall adhere to the PVC with 100 percent epoxy non-shrink grout.

6. Bench walls shall be constructed of sewer brick (Grade SS) and bench filled with concrete. Bench walls shall be carried a minimum of one brick course above top of highest pipe entering the manhole. Slope the top surface of the benching towards the channel at a pitch of approximately ½-inch/foot.

7. After initial setting bare concrete or grout shall be waterproofed with coal tar coating.

E. Roof Slabs

1. Slab shall be formed to fit into ends of vertical pipe and shall have full bearing for its entire circumference. The slab shall be set in a bed of cement mortar.

2. Opening diameter shall match manhole casting inside base diameter.

3. The location of center of opening for frame and cover shall be 1 foot 6 inches from inside of manhole wall unless otherwise noted.

F. Frames:

1. All manhole frames shall be set firmly in a bed of mortar not less than ½-inch thick. Concrete fill shall be placed around the outside as shown on the details and kept 2 inches below the top of the frame.

2. Precast grade rings set in mortar shall be used to bring manhole frames to grade, maximum 8 inches height for grade ring.

3. The frame and cover shall be depressed below edge of pavement elevation as indicated on the contract drawings.

G. The Contractor shall be responsible for maintaining and keeping all manholes clean and free of debris until completion of the Contract.

3.4 DROP MANHOLES

A. Wherever the invert of the entering sewer is more than 2 feet above the invert of the outlet sewer,
it shall be connected with a vertical inside drop with a clean-out pipe half bricked up.

B. The clean-out opening in the barrel of the manhole shall be cut in after the manhole wall pipe is in place. The joint between the clean-out pipe and the manhole wall shall be thoroughly sealed with cement mortar on the inside and bituminous joint material on the outside.

3.5 CONNECTION TO EXISTING MANHOLE(S) OR STRUCTURE(S)

A. Where noted on the Drawings or as directed by the Architect/Engineer, the Contractor shall make connection to existing manholes or structures. The use of excessive force or blunt instruments is prohibited in installing the pipe into the existing wall.

If a stub exists and matches the size of the new sewer, the Contractor shall connect to the stub. The stub to manhole connection should be checked and repaired if damaged or in poor shape. If stub does not match the size of the new sewer, the stub shall be removed and the new sewer shall be inserted into the manhole.

If no stub exists, neatly core drill a hole through the existing wall, taking care to achieve the minimum diameter hole required to install the pipe true to line and grade, as shown on the contract drawings or as directed by the Architect/Engineer, and in a manner which will not effect the structural integrity of the existing concrete. The structure shall be maintained in good repair.

For sanitary manholes or structures only, provide an approved flexible and watertight connection at the wall. For other structures, after inserting the connecting pipe, fill the annular space with non-shrink grout.

B. In making the connection to existing manhole(s), it shall be the Contractor’s responsibility to dewater the structure in order to make the connection.

C. The manhole shall be visually inspected by the Architect/Engineer for tightness of fit at all new joints.

3.6 MANHOLE CONNECTION TO EXISTING SEWERS (DOGHOUSE) (if required)

A. Where noted on the contract drawings or as directed by the Architect/Engineer, the Contractor shall provide a new connection to the existing sewer system by constructing a new manhole over the existing main. The Contractor shall be responsible for locating the existing service. Any damage to the existing sewer as a result of this work shall be repaired by the Contractor immediately and at no additional cost to the Owner.

B. Details of this connection shall be as shown on the contract drawings. Temporary support for the existing sewer shall be provided until the bench is poured. A watertight seal around the barrel openings of the existing main shall be provided.

C. Provide necessary adapters and specials required to make the connections.

D. Do work at such times and in such a manner as to cause a minimum of interruption to existing services.
E. The existing sewer shall remain in service as work progresses.

3.7 RAISE EXISTING MANHOLE TO FINISHED GRADE

A. The existing manhole structure shall be excavated to the minimum depth necessary, a vertical riser installed and the top cone or flat roof section raised to finished grade.

B. The vertical riser section shall be coated with one coat of Conseal CS-55 Coal Tar and the joints sealed tightly with joint sealer all around and two coats of Conseal CS-55 inside and outside.

C. The manhole shall be visually inspected by the Architect/Engineer for tightness of fit at all joints.

3.8 LOWER EXISTING MANHOLE TO FINISHED GRADE

A. The Contractor shall submit for approval the method by which the manhole frame and cover will be lowered.

B. The existing manhole structure shall be excavated to the minimum depth necessary.

C. If sufficient adjusting rings exist to meet the proposed lower grade, the Contractor shall appropriately adjust these rings and reset grade rings and frame and cover in mortar. The adjustment rings shall be coated with one coat of Koppers Super Service Black Coal Tar and the joints sealed tightly with joint sealer all around and two coats of Koppers Super Service black inside and outside.

D. If grade rings do not exist or the removal/adjustment of grade rings is insufficient to meet the lower proposed grade, the Contractor shall remove a vertical riser section and replace with a new vertical riser of appropriate size to meet the necessary grade with adjustment rings and frame and cover completed.

E. The vertical riser section shall be coated with one coat of Conseal CS-55 Coal Tar and the joints sealed tightly with joint sealer all around and two coats of Conseal CS-55 inside and outside.

F. The manhole shall be visually inspected by the Architect/Engineer for tightness of fit at all joints.

3.9 TESTING

A. Completed sanitary manholes only shall be subject to vacuum tests. When the sanitary sewer is tested and approved by the Architect/Engineer, the manholes shall be tested. The inlet and outlet pipe for the manholes shall be plugged with a plug that allows no leakage.

B. The test head shall be placed inside the 24-inch opening and the seal inflated in accordance with the manufacturer’s recommendations.

C. A vacuum of 10 inches of mercury shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum to drop to 9 inches. The manhole shall
pass the test if the time is greater than the following:

<table>
<thead>
<tr>
<th>Diameter of Manhole</th>
<th>Time (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>48 inches</td>
<td>60</td>
</tr>
<tr>
<td>60 inches</td>
<td>75</td>
</tr>
<tr>
<td>72 inches</td>
<td>90</td>
</tr>
</tbody>
</table>

D. If the manhole fails the initial test, necessary repairs shall be made. Retesting shall proceed until satisfactory results are obtained.

E. Equipment: NPC manhole vacuum tester, as manufactured by NPC Systems, Inc. of Worcester, MA, or approved equal.

F. All structures, manholes, and drop inlets shall be visually inspected for tight joints and neat

3.10 REJECTION AND REPAIR

A. Manhole sections shall be subject to rejection on account of failure to conform to any of the specification requirements. In addition, individual sections of manhole sections may be rejected because of any of the following:

1. Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.
2. Defects that indicate imperfect proportioning, mixing, and molding.
3. Surface defects indicating honeycombed or open texture.
4. Damaged or cracked ends, where such damage would prevent making a satisfactory joint.
5. Any continuous crack having a surface width of 0.01 inch (0.25 mm) or more and extending for a length of 12 inches (305 mm) or more, regardless of position in the section wall.
6. Improper waterproofing materials or mil thickness.

B. Manhole sections may be repaired with prior approval of the Architect/Engineer, if necessary, because of occasional imperfections in manufacture or accidental injury during handling and will be acceptable if, in the opinion of the Architect/Engineer, the repairs are sound and properly finished and cured, and the repaired manhole sections conform to the requirements of this specification.

3.11 MARKING AND PAINTING

A. Name and trademark of the manufacturer, as well as manhole number, shall be clearly marked on each manhole section.

B. Marking shall be indented into the manhole bases, risers, and top sections or shall be painted thereon with waterproof paint.
C. The precast manufacturer shall apply bitumastic coal tar to all precast sections as described in Part 2- Precast Circular Manhole Sections.

D. Immediately after installation is completed, the Contractor shall touch up all marks, scars, and imperfections found and paint all interior surfaces not factory coated with two coats of coal tar, Conseal CS-55 or approved equal. Work shall be done in accordance with the paint manufacturer’s recommendation.

E. Cover inside and outside of joints all around with flexible joint sealer and two coats, Conseal CS-55 or approved equal. Coating shall be required for sanitary and storm manholes.

3.12 ALUMINUM STOP LOGS

A. Install aluminum stop log in accordance with the manufacturer’s recommendations and installation instructions.

B. Embed aluminum frame into pre-cast concrete structure, coordinate with the pre-cast structure and stop log manufacturer as necessary.

C. Install under the under supervision and to the satisfaction of the Onondaga County of Department of Water Environment Protection (OCDWEP). Notify OCDWEP (315-435-5402) at least 48 hours in advance of any sanitary sewer related work.

END OF SECTION 330513
SECTION 334100 - STORM UTILITY DRAINAGE PIPING

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. Extent of storm sewer system work includes, but is not limited to the following:
1. Complete connection to proposed and existing building laterals, roof downspouts, roof drains or foundation drains.
2. Furnish and install new concrete catch basins and PVC drain basins
3. Furnish and install new storm manhole
4. Furnish and install clean outs complete
5. Furnish and install storm sewer drainage and underdrain piping, fittings, and accessories
6. Flushing existing and new storm pipes, capturing and removing debris

B. Contractor shall be responsible to maintain flow through existing storm sewer systems by whatever means necessary, including pumping, temporary piping etc. Contractor shall coordinate with the Architect/Engineer for approval of proposed methods.

C. Related Sections:
1. Division 31 Section “Earth Moving”
2. Division 31 Section “Erosion and Sediment Control”
3. Division 32 Section “Turf and Grasses”
4. Division 33 Section “Site Waste Utility Sewerage Piping”
5. Division 33 Section "Precast Manholes"

1.3 QUALITY ASSURANCE
A. All precast concrete sections and structures, and all castings shall each be the product of a single manufacturer who can furnish evidence of satisfactory experience in the product of high quality products of the type indicated and specified.

B. Pipe and pipe fittings shall be produced in a plant of recognized reputation that is regularly engaged in the production of pipe conforming to the specified standards. Pipe and pipe fittings of the same type shall be the product of a single manufacturer.

C. All pipe and pipe fittings, structures, and castings shall be of good quality and free from defects which would make it unfit for the use intended.

D. Contractor shall be responsible for furnishing all labor, materials, surveying instruments and tools necessary to establish and maintain all lines and grades.
1.4 SUBMITTALS

A. Submit manufacturer’s data and shop drawings for precast structures, frames and covers, coatings, pipe connectors, etc.

B. Manufacturer’s certifications of compliance for precast concrete sections and castings shall be submitted.

C. Manufacturer's literature and catalog cuts including technical, material specifications, dimensions, tolerances, and installation information for all underdrain products, pipe and pipe fittings, and geotextile fabrics.

D. Shop drawings, catalog cuts, and manufacturer’s literature for all pipe and pipe fittings, to include coatings and linings, material specifications, dimensions, tolerances, and all related data shall be submitted.

E. Manufacturer’s certification that pipe supplied meets the required specifications shall be submitted.

F. Pipe manufacturers shall furnish Certificates of Compliance on pipe, with each load of pipe supplied. Immediately turn certificates over the Architect/Engineer. Materials delivered to the site without accompanying certificates will be subject to rejection.

G. Submit record drawings indicating actual location of pipe runs, connections, wyes, stubs, structures and associated invert elevations. Record actual vertical separations at all exposed utility crossings. Record invert elevations at all utility crossings.

H. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Each length of pipe delivered to the site shall be clearly marked at the factory with the name of the manufacturer, class of pipe, pipe diameter and all else as required by the codes, standards, and specifications referred to under this section. Omission of this information will be cause for rejection of pipe.

B. Store all materials in accordance with manufacturer’s approved instructions. Store all materials so they can be easily inspected and so they will not be damaged prior to installation.

C. Carefully handle all pipes and fittings when loading and unloading to avoid damage to pipe, coatings, or linings. Pipe or fittings with damaged coatings or linings shall be repaired or replaced by the Contractor at his expense and to the satisfaction of the Architect/Engineer. Lift pipes and fittings by hoists or lower on skid ways in a manner to avoid shock. Lower pipe into trench with derricks, rope, or suitable equipment for the safety and protection of workmen, materials, equipment, property, and the work.

D. Do not dump or drop pipe and fittings. Those that are dumped or dropped are subject to rejection by Architect/Engineer.
1.6 ABBREVIATIONS

CIP Cast Iron Pipe
CMP Corrugated Metal Pipe
DIP Ductile Iron Pipe
PVC Polyvinyl Chloride Pipe
PCPP Perforated Corrugated Polyethylene Drain Pipe
SICPP Smooth Interior Corrugated Polyethylene Pipe

1.7 MATERIAL TESTS

A. Various tests and checks shall be performed, as specified herein, to determine compliance with the specifications and drawings. The Contractor is advised that failure of a test is suitable grounds for the Architect/Engineer to order that portion of the work removed and reconstructed, if necessary, to meet the requirements of the Contract Documents.

1.8 JOB CONDITIONS

A. The drawings indicate the required structure and pipe sizes, and locations of all structures, piping and appurtenances. Verify all locations and immediately notify Architect/Engineer of any discrepancies or conflicts.

B. Contractor shall verify that survey benchmark and intended elevations for the work are as indicated. Contractor shall verify existing site conditions.

C. Utilities shown on the Contract Drawings are for the convenience of the Contractor, exact locations are not guaranteed. The Contractor shall verify existing utilities with the proper authorities.

D. The Contractor shall take precautions to protect from harm the work of other contractors on site, existing facilities, as well as adjacent property. The Contractor shall be responsible for all damage or injury done to pipes, structures, utilities, pavement, buildings, property or person as a result of work to complete this contract. The Contractor at his own expense shall repair or replace such property or item to the satisfaction of the property owner, utility owner, public agency having jurisdiction, Architect/Engineer and Owner's Designated Representative.

1.9 PROTECTION OF WATER AND GAS LINES FROM STORM SEWER

A. Parallel Water (or Gas) and Sewer Lines – Potable water (or gas) lines and pipelines carrying sewage, (including vaults, manholes or structures) shall not be installed any closer than 10 feet horizontally from one another. The distance shall be measured outside edge to outside edge of pipe or structure.

B. Water (or Gas) and Sewer Line Crossings – Whenever water (or gas) and sewer lines must cross, the sewer must be situated below the water (or gas) line with at least an 18-inch clear, vertical separation between top of sewer line and bottom of water line. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water (or gas) line joints (at least one full laying length of water (or gas) pipe shall be centered over the sewer). In no case
shall a water (or gas) line pass under a sewer unless specifically approved by the Architect/Engineer. Where a water (or gas) line is approved to cross under a sewer, adequate structural support (compacted select fill) shall be provided for the sewer to prevent excessive deflection of joints and settling of the sewer on the water (or gas) line.

C. Special Conditions – When it is not practical to maintain a 10-foot horizontal separation between sewer and water (or gas) lines, immediately notify the Architect/Engineer. If the Architect/Engineer concurs, the utilities shall be installed as follows:

1. For water (or gas) lines that pass over sewers: the water (or gas) line shall be installed as far away from the sewer as possible with a minimum horizontal separation of 3 feet and a minimum of 6-inches above the sewer, as measured from the invert of the water (or gas) line to the crown of the sewer.

2. For water (or gas) lines installed below sewers: the water (or gas) line shall be installed 18-inches below the invert of the sewer or by one of the following as approved by the Architect/Engineer with a variance obtained from the appropriate Department of Health office:
   a. Construct the sewer using water main standard pipe and testing said pipe at 150 psi, or
   b. Encase, sleeve, or otherwise envelope the water main or sewer to maximize protection of the water main.

D. Special Conditions – Crossing Lines – When it is impossible to obtain proper vertical separation, immediately notify the Architect/Engineer. If the Architect/Engineer concurs, the utilities shall be installed as follows:

1. For water (or gas) lines that pass over sewers: If 18-inches of vertical separation is not feasible and the vertical separation is between 6- and 18-inches, all water (or gas) line joints within 20 feet of the sewer shall be encased in control density fill.

2. For water (or gas) line that pass below sewers: If 18-inches of vertical separation is not feasible one of the following shall be completed as approved by the Architect/Engineer with a variance obtained from the appropriate Department of Health office:
   a. Construct the sewer using water main standard pipe and testing said pipe at 150 psi, or
   b. Encase, sleeve, or otherwise envelope the water main or sewer for a distance equal to two full lengths of water pipe to maximize separation between the crossing and unprotected joint.

E. Refer to Division 22 Section “Facility Sanitary Sewers

PART 2 – PRODUCTS AND MATERIAL

2.1 GENERAL
A. Caps and Plugs – Water tight, of similar manufacturer and producing the same joint conditions as the pipe on which the cap or plug is placed.

A. Foundation Materials:
   1. Gravel or crushed stone bedding shall be as detailed on the Contract Drawings and as specified in Division 31 Section “Earth Moving”.
   2. Select earth backfill shall be as detailed on the Contract Drawings and as specified in Division 31 Section “Earth Moving”.

B. Pipe Adapters – Join pipes of different materials with adapters specifically manufactured for that purpose and as approved by the Architect/Engineer. Where dissimilar materials join, such that galvanic action may produce corrosion, provide dielectric couplings to preclude damage to the materials.

C. Concrete for Pipe Encasements and Cradles – Class A concrete per NYSDOT Standard Specification Section 501.

D. Flowable concrete fill for sewer abandonment shall be Controlled Low Strength Material (CSLM) as specified in Division 31 Section “Earth Moving”.

2.2 CAST IRON PIPE – GRAVITY STORM ROOF DRAIN PIPE ADJACENT TO BUILDING

A. Cast Iron Soil Pipe and Fittings: Conform to ASTM A-74 (service weight, bitumen coated).

B. Cast Iron Soil Pipe Joint Device: Bell and spigot with rubber gasket conforming to ASTM C564.

C. Storm pipe within three (3) feet of the exterior of the building shall be CIP.

2.3 POLYVINYL CHLORIDE (PVC) PIPE – SDR-21

A. Pipe and Pipe Fittings
   1. Materials shall conform to Division 33 Section “Site Waste Utility Sewerage Piping”

2.4 CORRUGATED POLYETHYLENE PIPE (CPP)

A. Corrugated polyethylene pipe storm sewers shall be high-density corrugated polyethylene pipe with corrugated interior and exterior. Three-inch to 10-inch diameter pipe shall conform to AASHTO M252 Type C and 12-inch to 36-inch diameter pipe shall conform to AASHTO M294, Type S. Material compounds shall conform to ASTM D3350. Pipe shall be Heavy Duty Corrugated Polyethylene Pipe as manufactured by Hancor, or Highway Culverts as manufactured by Advance Drainage Systems, Inc., or approved equal.

B. Pipe joints and fittings shall be of the same material as the pipe.
2.5 SMOOTH INTERIOR CORRUGATED POLYETHYLENE PIPE (SICPP)
A. Corrugated polyethylene pipe storm sewers shall be high-density corrugated polyethylene smooth interior pipe. Four-inch to 10-inch diameter pipe shall conform to AASHTO M252 with the addition of smooth interior and 12-inch to 36-inch diameter pipe shall conform to AASHTO M294, Type S. Material compounds shall conform to ASTM D3350. Pipe shall be Hi-Q as manufactured by Hancor, N-12 as manufactured by Advance Drainage Systems, Inc., or approved equal.
B. Pipe joints and fittings shall be of the same material as the pipe.

2.6 PERFORATED CORRUGATED POLYETHYLENE UNDERDRAIN PIPE (PCPP)
A. Perforated corrugated polyethylene drain pipe 4 inches through 10 inches in diameter shall be flexible high density corrugated polyethylene, corrugated on the inside and outside conforming to AASHTO M252 except that tubing manufactured from material meeting ASTM D1248, Class B shall also be acceptable. Pipe shall be heavy-duty AASHTO pipe as manufactured by Hancor, or approved equal.
B. Perforated corrugated polyethylene tubing and fittings 12 inches and 15 inches diameter shall meet the requirements of AASHTO M292 Type CP.
C. Pipe joints and fittings shall be of the same material as the pipe.
D. The geotextile fabric around the under drain shall be Mirafi 140N as manufactured by Mirafi, or approved equal.
E. The underdrain filter stone shall be as specified in Division 31 Section “Earth Moving”.

2.7 CATCH BASINS (HEAVY DUTY)
A. Provide precast or cast-in-place concrete structures as shown on the Contract Drawings. Precast concrete strength shall meet 4,000 psi at 28 days. Structures shall be designed for AASHTO H-20 loading with 30 percent impact.
B. Frame and grate shall be galvanized NYSDOT rectangular grate, bicycle proof, meeting AASHTO H-20 design as indicated on the Contract Drawings.
C. The interior and exterior of the catch basin shall be coated with two coats of Conseal CS-55, or approved equal.
D. Where shown on the Contract Drawings, provide catch basin with cast iron catch basin trap Model R-3704 as manufactured by Neenah Foundry Company, or approved equal.

2.8 DRAIN BASIN
A. Shall be manufactured from PVC pipe stock, utilizing a thermo-molding process to reform the pipe stock to the specified configuration.
B. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. This joint tightness shall conform to ASTM D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seal. The flexible elastomeric seals shall conform to ASTM F477.

C. The pipe bell spigot shall be joined to the main body of the drain basin or catch basin.

D. The raw material used to manufacture the pipe stock that is used to manufacture the main body and pipe stubs of the surface drainage inlets shall conform to ASTM D1784 cell class 12454.

E. The grates and frames furnished for all surface drainage inlets shall be ductile iron for sizes 8”, 10”, 12”, 15”, 18”, 24” and 30” and shall be made specifically for each basin so as to provide a round bottom flange that closely matches the diameter of the surface drainage inlet. Grates for drain basins shall be capable of supporting H-20 wheel loading. 12” and 15” square grates will be hinged to the frame using pins. Metal used in the manufacture of the castings shall conform to ASTM A536 grade 70-50-05 for ductile iron. Grates shall be provided painted black.

2.9 STORM MANHOLES
A. Precast storm manholes shall be as specified in Division 33 Section “Precast Manholes”.

2.10 CONNECTIONS TO EXISTING PIPE LINES
A. Provide connections where shown on the Contract Drawings. Where no details of the connections are shown, submit a proposal for approval, showing fittings, adapters, and procedures used.

2.11 TRACK TRENCH DRAINS
A. A grated trench drain shall be installed on the inside of the track adjacent to the turf field. A slotted trench drain shall be installed in the D-zone and steeple chase areas as shown on the plans.

B. Slotted Trench Drain – The slotted trench drain shall be the Sport System 2000. The minimum slot dimension shall be 0.625”. The catch basins in the grated section shall be system 4000 In-Line Series as manufactured by ACO Polymer Products, Inc. or approved equal.

C. The channels shall be manufactured from polyester resin polymer concrete with the following minimum properties:
   1. Compressive Strength: 14,000 PSI
   2. Flexural Strength: 4,000 PSI
   3. Tensile Strength: 1,500 PSI
   4. Water Absorption: 0.07%
   5. Frost Proof: Yes
   6. Dilute Acid & Alkali Resistant: Yes
D. The system shall have 4" nominal internal width and a 6.1" overall width. All channels shall be interlocking with a male/female joint.

2.12 CLEAN OUTS
A. Clean outs shall be constructed in accordance with Division 22 Section “Facility Sanitary Sewer”.

2.13 END SECTIONS
A. Provide end sections that meet NYSDOT 707-10 Galvanized Steel End Sections.
B. Galvanized steel end sections shall be manufactured from material meeting the requirements of AASHTO M218 and ASTM A 929.
C. The end sections shall be manufactured so that there are no loosely formed seams or ragged shear edges. The markings on the section shall be legible. The metallic coating shall not be bruised, broken, or damaged.
D. The end section shall be attached to the pipe with a strap band or threaded rod provided by the manufacturer.

2.14 DETECTABLE UNDERGROUND MARKING TAPE
A. For all PVC, SICPP, or DIP sewer pipe or laterals, provide detectable warning tape. Refer to Division 31 Section “Earth Moving”.

2.15 INLINE CHECK VALVE
A. Provide rubber elastomer inline check valve with stainless steel 316 expansion clamps that compatible with the host pipe. Use Tideflex Checkmate UltraFlex Inline Check Valve or approved equal.

2.16 INSERT TEE
A. Provide three piece lateral connection consisting of a PVC hub, rubber sleeve, and stainless steel 301 clamp. Use rubber sleeve and PVC gasket conforming to ASTM F477. Use Inserta Tee or approved equal.

PART 3 – EXECUTION

3.1 PREPARATION
A. Thoroughly clean interiors of pipes, fittings, and appurtenances, joint surfaces, and gaskets prior to installation. Maintain pipes and fittings clean.
B. Verify that excavation is in the proper location, that pipes and structures have been installed at the correct elevations, and that the subgrade has been properly prepared.

3.2 PIPE AND STRUCTURE INSTALLATION - GENERAL

A. Trenching and related excavation work shall be completed in accordance with Division 31 Section “Earth Moving” and in a manner as approved by the Architect/Engineer. Remove all boulders, organic or spongy material, and other deleterious matter. Verify that trench excavation is ready to receive work and that excavations, dimensions, and elevations are as indicated on drawings. Remove large stones or other hard matter, which could damage piping or impede consistent backfilling or compaction.

B. Pipe Foundation: All pipes, fittings, or specials to be installed shall be properly bedded in uniformly supported on pipe foundations of the type specified in Division 31 Section “Earth Moving” and indicated on the Contract Drawings.

C. Firmly bed pipe in the required depth of aggregate in such a manner that the pipe barrel is uniformly supported and cradled throughout its length. Provide suitable depressions where required in the foundation material to permit adequate bedding of the bells or other projections. The total depth of bedding shall be constant across the trench width.

D. Install storm structures and pipelines to the required lines and grades indicated on the drawings, or as directed by the Architect Engineer using an approved method of control.

E. Carefully lower pipes, fittings, and structures into the trench. Apply joint lubricant (if required) in accordance with the approved manufacturer’s recommendations. Join pipe sections and fittings. Join pipe and structures.

F. Select pipe and fittings so that there will be as small a deviation as possible at the joints and so that inverts present a smooth surface. Pipe and fittings, which do not fit together to form a tight fitting joint, are not permitted.

G. Use only mechanical cutters for cutting pipe.

H. Cut ends of pipe which terminate at catch basins, manholes, or other structures cleanly and trim to a neat, sheared edge, flush with the inside wall of the structure.

I. Maintain cleanliness of installed pipe, fittings, and structure interiors throughout the work. Plug ends when installation is not in progress so that dirt, foreign matter, water, animals, and people do not enter the work. Drainage of construction excavations through installed pipes shall not be permitted.

J. Maintain the excavation free of water during the progress of the work. No pipes or structures shall be laid in water nor shall there be any joints made up in water. No separate allowance for pumping or otherwise removing water will be made. All slides or cave-ins of the trenches or cuts shall be remedied at the expense of the Contractor, and to the satisfaction of the Architect/Engineer.
3.3 ADJUSTMENT OF CATCH BASINS TO FINISHED GRADE

A. Adjustment of catch basins shall be completed as specified in Division 33 Section “Precast Manholes” and as shown on the drawings.

3.4 DRAIN BASINS

A. The specified PVC surface drainage inlet shall be installed using conventional flexible pipe backfill materials and procedures. The backfill material shall be crushed stone or other granular material meeting the requirements of class 2 material as defined in ASTM D2321. Bedding and backfill for surface drainage inlets shall be 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.

3.5 END SECTIONS

A. Strap or rod shall be tightened securely around the pipe.

B. Support the invert of the end section evenly on the bedding. Match the alignment of the end section with the pipe. Provide compaction of backfill around the end section.

3.6 TRACK SLOT DRAINS

A. The track slot drains and catch basins shall be installed in accordance with the contract drawings and manufacturer’s recommendations.

3.7 CLEAN OUTS

A. Clean outs shall be installed in accordance with the Division 22 Section “Facility Sanitary Sewer” and as shown on the Contract Drawings.

3.8 TESTING

A. Deflection testing on all 12-inch and under storm piping shall be completed. Tests shall be same as for sanitary sewer Division 22 Section “Facility Sanitary Sewer”.

B. Deflection testing of underdrain piping and storm piping is not required.

3.9 ABANDONMENT OF SEWERS AND APPURTEANCES

A. When the new storm sewer has successfully passed the specified testing and has been placed in service, the existing storm sewer, to limits shown on the Contract Drawings, is to be abandoned.

B. Storm sewer piping located under or within 5 feet outside of proposed building limits and designated for abandonment shall be removed in its entirety.
C. Unless otherwise shown on the plans, storm sewer piping designated for abandonment and located more than 5 feet outside the proposed building limits shall be capped and plugged and abandoned in place. Refer to plans for removals.

D. Structures located under or within 5 feet outside of proposed building limits shall be removed in their entirety. As a minimum, all other structures designated for abandonment shall be removed to within 3 feet of the proposed finished grade and filled with controlled density fill.

3.10 FIELD QUALITY CONTROL

A. In the presence of the Owner’s Designated Representative, inspect each length of pipe and each structure delivered to the job for flaws, cracks, dimensional tolerance and compliance with the applicable specifications. Only pipes, fittings, and structures accepted by the Owner’s Designated Representative and so marked shall be installed in the work.

B. The Contractor shall inspect pipe joints and verify that they have been properly installed and made up, and free from sags, high spots, and excessive deflections.

C. The Owner's Designated Representative shall inspect each stretch of completed pipeline and structure prior to backfilling, to insure compliance with the Contract Documents. The Contractor shall not continue with backfilling operations prior to inspection by the Owner's Designated Representative, utility representatives or prior to recording as built information.

D. Afford Architect/Engineer access to the work so that he may spot check the installations or check each length of pipe immediately after it has been installed, or check it at any time after installation.

E. Contractor shall request Owner's Designated Representative inspection prior to and immediately after placing aggregate cover over pipe.

F. Upon completion of construction of the storm sewer, including trench backfill, the Contractor shall clean and flush all pipes. The system shall be left free of all stones, sand, silt, or mortar projects. The benches and inverts of manholes and bottoms of inlets shall have all mortar dropping chipped away to leave a smooth, clean surface.

G. All materials flushed from the storm sewer shall be intercepted and removed to prevent the materials from entering the existing storm sewer system.

3.11 DAMAGED FACILITIES

A. Any section of piping that is found defective in material, alignment, grade, joint, or otherwise, shall be corrected at no additional cost to the Owner.

B. In the event that dirt, debris, or any other foreign material has entered any portion of the piping or structures, flush the piping or structure with clean water. Continue the flushing process until the piping or structure is clean, as determined by Architect/Engineer.

C. Any damage done to existing utility mains or their appurtenances as a result of work under this Contract shall be repaired or replaced by the Contractor to the satisfaction of the Architect/Engineer at no additional cost to the Owner.
3.12 INLINE CHECK VALVE

A. Confirm size and material of host pipe prior ordering or purchasing materials, or submitting shop drawings / cut sheets.

B. Prior to installation clean and ensure host pipe is free of dirt and debris to ensure a secure water tight seal around check valve.

C. Install inline check valve in accordance with manufactures installation instructions.

3.13 INSERT TEE

A. Install insert tee in accordance with manufacturer’s installation instructions and provide water tight connection

B. Confirm size and material of connecting pipes prior ordering or purchasing materials, or submitting shop drawings / cut sheets.

C. Use whole saw to core hole into host pipe.

END OF SECTION 334100