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NEW CONSTRUCTION
OF
NORTHVIEW MIDRISE
PITTSBURGH, PENNSYLVANIA

IFB No. ARMDC 600-26-17G
PHFA Project No. TC2017-142

100% CONSTRUCTION DOCUMENT
PROJECT MANUAL 2

NOVEMBER 29, 2017
REVISION # 1 FEBRUARY 28, 2018

HOUSING AUTHORITY OF THE CITY OF PITTSBURGH

NEW CONSTRUCTION
OF
NORTHVIEW MIDRISE

IFB No. ARMDC 600-26-17G
"G" GENERAL CONSTUCTION No. 600-26-17-G
"E" ELECTRICAL CONSTRUCTION No. 600-26-17-E
"P" PLUMBING CONSTRUCTION No. 600-26-17-P
"H" MECHANICAL CONSTRUCTION No. 600-26-17-H

PROJECT MANUAL
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P=PLUMBING (& Fire Protection)
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All Specifications are dated November 29, 2017, or February 28, 2018 Revision #1

SECTION 210500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

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. Mechanical sleeve seals.
3. Sleeves.
4. Escutcheons.
5. Grout.
6. Fire-suppression equipment and piping demolition.
7. Equipment installation requirements common to equipment sections.
8. Painting and finishing.
9. Concrete bases.
10. Supports and anchorages.

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, crawlspaces, 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.

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

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic.

G. 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. Mechanical sleeve seals.
2. Escutcheons.

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 Fire-Suppression 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.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

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. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21 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 21 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. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

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

H. Solvent Cements for Joining CPVC Plastic Piping: ASTM F 493.

2.4 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Available Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

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

2.5 SLEEVES

A. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends and a welded steel water stop, unless otherwise indicated.

B. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

2.6 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.7 GROUT

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

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21 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 free of sags and bends.

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

J. Install piping to allow application of insulation.

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

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. 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 with spring clips.
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, stamped-steel type with set screw.
h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

2. Existing Piping: Use the following:

a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated finish.
f. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
b. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

P. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using 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.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Q. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

S. Verify final equipment locations for roughing-in.

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

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21 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. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. 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.

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

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

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

3.3 PAINTING

A. Painting of fire-suppression systems, equipment, 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.

3.4 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of 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. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.5 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 fire-suppression materials and equipment.

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

3.6 GROUTING

A. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 210500

SECTION 211100 - FACILITY FIRE-SUPPRESSION WATER-SERVICE 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 fire-suppression water-service piping and related components outside the building and service entrance piping through floor and/or wall into the building.

B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

C. Related Sections:

1. Division 21 Section "Wet-Pipe Sprinkler Systems" for wet-pipe fire-suppression sprinkler systems inside the building.

2. Division 21 Section "Electric-Drive, Centrifugal Fire Pumps Diesel-Drive, Centrifugal Fire Pumps Electric-Drive, Vertical-Turbine Fire Pumps Diesel-Drive, Vertical-Turbine Fire Pumps" for fire pumps, pressure-maintenance pumps, and controllers.

1.3 SUBMITTALS

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

B. Shop Drawings:

1. Where precast concrete vault assemblies are being provided, detail vault assemblies and indicate dimensions, method of field assembly, and components.

2. Wiring Diagrams: For power, signal, and control wiring.

C. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

D. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.

2. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

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

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with the "Approval Guide," published by FM Global, or UL's "Fire Protection Equipment Directory" for fire-service-main products.

E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-suppression water-service piping.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.

2. Protect valves against damage to threaded ends and flange faces.

3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves, including fire hydrants, according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.

2. Protect from weather. Store indoors and maintain temperature higher than ambient dew point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.6 COORDINATION

A. Coordinate connection to water main with utility company.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON PIPE AND FITTINGS

A. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.

B. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end.

C. Grooved-End, Ductile-Iron Pipe Appurtenances:

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, Inc.

b. Shurjoint Piping Products.

c. Star Pipe Products.

d. Victaulic Company.

2. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.

3. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

D. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

1. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

E. Flanges: ASME B16.1, Class 125, cast iron.

2.2 SPECIAL PIPE FITTINGS

A. Ductile-Iron Flexible Expansion Joints:

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. EBAA Iron, Inc.

b. ROMAC Industries Inc.

c. Star Pipe Products.

2. Description: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections. Assemble components for offset and expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

3. Pressure Rating: 250 psig minimum.

B. Ductile-Iron Deflection Fittings:

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. EBAA Iron, Inc.

2. Description: Compound, ductile-iron coupling fitting with sleeve and one or two flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

3. Pressure Rating: 250 psig minimum.

2.3 JOINING MATERIALS

A. Gaskets for Ferrous Piping and Copper-Alloy Tubing: ASME B16.21, asbestos free.

B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series.

C. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

2.4 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Tubular-Sleeve Pipe Couplings:

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. Cascade Waterworks Manufacturing.

b. Dresser, Inc.; Dresser Piping Specialties.

c. Ford Meter Box Company, Inc. (The); Pipe Products Division.

d. JCM Industries.

e. ROMAC Industries Inc.

f. Smith-Blair, Inc.; a Sensus company.

g. Viking Johnson.

2. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners, and with ends of same sizes as piping to be joined.

3. Standard: AWWA C219.

4. Center-Sleeve Material: Manufacturer's standard.

5. Gasket Material: Natural or synthetic rubber.

6. Pressure Rating: 150 psig minimum.

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

2.5 CORPORATION VALVES AND CURB VALVES

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. Amcast Industrial Corporation.

2. Ford Meter Box Company, Inc. (The); Pipe Products Division.

3. Jones, James Company.

4. Master Meter, Inc.

5. McDonald, A. Y. Mfg. Co.

6. Mueller Co.; Water Products Division.

7. Red Hed Manufacturing & Supply.

B. Corporation Valves: Comply with AWWA C800. Include saddle and valve compatible with tapping machine and manifold.

1. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.

2. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.

3. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.

C. Curb Valves: Comply with AWWA C800 for high-pressure service-line valves. Valve has bronze body, ground-key plug or ball, wide tee head, and inlet and outlet matching service piping material.

D. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches in diameter.

1. Shutoff Rods: Steel; with tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

E. Meter Valves: Comply with AWWA C800 for high-pressure service-line valves. Include angle- or straight-through-pattern bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.

2.6 GATE VALVES

A. UL-Listed or FM-Approved Gate 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. American AVK Company; Valve & Fittings Division.

b. American Cast Iron Pipe Company; American Flow Control Division.

c. American Cast Iron Pipe Company; Waterous Company Subsidiary.

d. Clow Valve Company; a division of McWane, Inc.

e. Crane Co.; Crane Valve Group; Jenkins Valves.

f. Crane Co.; Crane Valve Group; Stockham Division.

g. East Jordan Iron Works, Inc.

h. Hammond Valve.

i. Kennedy Valve; a division of McWane, Inc.

j. M&H Valve Company; a division of McWane, Inc.

k. Milwaukee Valve Company.

l. Mueller Co.; Water Products Division.

m. NIBCO INC.

n. Shurjoint Piping Products.

o. Troy Valve; a division of Penn-Troy Manufacturing, Inc.

p. Tyco Fire & Building Products LP.

q. United Brass Works, Inc.

r. U.S. Pipe.

s. Watts Water Technologies, Inc.

2. 175-psig, UL-Listed or FM-Approved, Iron, OS&Y, Gate Valves:

a. Description: Iron body and bonnet and bronze seating material.

b. Standards: UL 262 and "Approval Guide," published by FM Global, listing.

c. Pressure Rating: 175 psig minimum.

d. End Connections: Flanged or grooved.

2.7 BUTTERFLY VALVES

A. UL Listed or FM-Approved Butterfly 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. Kennedy Valve; a division of McWane, Inc.

b. Milwaukee Valve Company.

c. Mueller Co.; Water Products Division.

d. NIBCO INC.

e. Pratt, Henry Company.

2. Description: Metal on resilient material seating.

3. Standards: UL 1091 and "Approval Guide," published by FM Global, listing.

4. Body Material: Cast or ductile iron.

5. Body Type: Wafer or flanged.

6. Pressure Rating: 175 psig.

2.8 CHECK VALVES

A. UL-Listed or FM-Approved Check 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. American Cast Iron Pipe Company; Waterous Company Subsidiary.

b. Clow Valve Company; a division of McWane, Inc.

c. Crane Co.; Crane Valve Group; Stockham Division.

d. Globe Fire Sprinkler Corporation.

e. Kennedy Valve; a division of McWane, Inc.

f. Kidde Fire Fighting.

g. Matco-Norca.

h. Mueller Co.; Water Products Division.

i. NIBCO INC.

j. Reliable Automatic Sprinkler Co., Inc.

k. Tyco Fire & Building Products LP.

l. United Brass Works, Inc.

m. Victaulic Company.

n. Viking Corporation.

o. Watts Water Technologies, Inc.

2. Description: Swing-check type with pressure rating, rubber-face checks unless otherwise indicated, and ends matching piping.

3. Standards: UL 312 and "Approval Guide," published by FM Global, listing.

4. Pressure Rating: 175 psig.

2.9 BACKFLOW PREVENTERS

A. Double-Check, Detector-Assembly 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:

a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.

b. Conbraco Industries, Inc.; Apollo Valves.

c. FEBCO; SPX Valves & Controls.

d. Watts Water Technologies, Inc.

e. Zurn Plumbing Products Group; Wilkins Water Control Products Division.

2. Standards: ASSE 1048 and UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.

3. Operation: Continuous-pressure applications.

4. Pressure Loss: 5 psig maximum, through middle one-third of flow range.

5. Size: Per drawings.

6. Body Material: Cast iron with interior lining complying with AWWA C550 or that is FDA approved.

7. End Connections: Flanged.

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

9. Accessories:

a. Valves: UL 262, "Approval Guide," published by FM Global, listing, approved; OS&Y gate type with flanged ends on inlet and outlet.

b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

B. Backflow Preventer Test Kits:

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. Conbraco Industries, Inc.; Apollo Valves.

b. FEBCO; SPX Valves & Controls.

c. Flomatic Corporation.

d. Watts Water Technologies, Inc.

e. Zurn Plumbing Products Group; Wilkins Water Control Products Division.

2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.10 FIRE-DEPARTMENT CONNECTIONS

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. Elkhart Brass Mfg. Company, Inc.

2. Fire-End & Croker Corporation.

3. Guardian Fire Equipment, Inc.

4. Kidde Fire Fighting.

5. Potter Roemer.

6. Reliable Automatic Sprinkler Co., Inc.

B. Description: Freestanding, with cast-bronze body, thread inlets according to NFPA 1963 and matching local fire-department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- high brass sleeve; and round escutcheon plate.

C. Standard: UL 405.

D. Connections: Two NPS 2-1/2 inlets and one NPS 4 outlet.

E. Inlet Alignment: Inline, horizontal.

F. Finish Including Sleeve: Polished chrome plated.

G. Escutcheon Plate Marking: "AUTO SPKR."

2.11 ALARM DEVICES

A. General: UL 753 and "Approval Guide," published by FM Global, listing, of types and sizes to mate and match piping and equipment.

B. Water-Flow Indicators: Vane-type water-flow detector, rated for 250-psig working pressure; designed for horizontal or vertical installation; with two single-pole, double-throw circuit switches to provide isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal when cover is removed.

C. Supervisory Switches: Single pole, double throw; designed to signal valve in other than fully open position.

D. Pressure Switches: Single pole, double throw; designed to signal increase in pressure.

2.12 SLEEVES

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

B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, standard-weight, zinc-coated, plain ends.

2.13 SLEEVE SEALS

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. Metraflex, Inc.

4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

C. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

D. Pressure Plates: Plastic. Include two for each sealing element.

E. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

2.14 GROUT

A. Standard: ASTM C 1107, Grade B, posthardening and volume adjusting, dry, hydraulic-cement grout.

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

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with excavating, trenching, and backfilling requirements in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.

B. Make connections larger than NPS 2 with tapping machine according to the following:

1. Install tapping sleeve and tapping valve according to MSS SP-60.

2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.

3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.

4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.

C. Make connections NPS 2 and smaller with drilling machine according to the following:

1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company's standards.

2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.

3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.

4. Install corporation valves into service-saddle assemblies.

5. Install manifold for multiple taps in water main.

6. Install curb valve in water-service piping with head pointing up and with service box.

D. Comply with NFPA 24 for fire-service-main piping materials and installation.

E. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

1. Install encasement for piping according to ASTM A 674 or AWWA C105.

F. Bury piping with depth of cover over top at least 36 inches, with top at least 12 inches below level of maximum frost penetration, and according to the following:

1. Under Driveways: With at least 36 inches of cover over top.

2. Under Railroad Tracks: With at least 48 inches of cover over top.

3. In Loose Gravelly Soil and Rock: With at least 12 inches of additional cover.

G. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.

H. Extend fire-suppression water-service piping and connect to water-supply source and building fire-suppression water-service piping systems at locations and pipe sizes indicated.

1. Terminate fire-suppression water-service piping at building floor slab or wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building's fire-suppression water-service piping systems when those systems are installed.

I. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

J. Comply with requirements in Division 21 Sections for fire-suppression-water piping inside the building.

K. Comply with requirements in Division 22 Section "Domestic Water Piping" for potable-water piping inside the building.

3.3 JOINT CONSTRUCTION

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

B. Install unions adjacent to each valve in tubing NPS 2 and smaller.

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

D. Ream ends of tubes and remove burrs.

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

F. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.

G. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts.

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

I. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

J. Do not use flanges or unions for underground piping.

3.4 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:

1. Concrete thrust blocks.
2. Locking mechanical joints.
3. Set-screw mechanical retainer glands.
4. Bolted flanged joints.
5. Heat-fused joints.
6. Pipe clamps and tie rods.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches in fire-suppression water-service piping according to NFPA 24 and the following:

1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.5 VALVE INSTALLATION

A. UL-Listed or FM-Approved Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

B. UL-Listed or FM-Approved Valves Other Than Gate Valves: Comply with NFPA 24.

C. MSS Valves: Install as component of connected piping system.

D. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

E. Pressure-Reducing Valves: Install in vault or aboveground between shutoff valves. Install full-size valved bypass.

3.6 WATER METER INSTALLATION

A. Install water meters, piping, and specialties according to utility company's written instructions.

3.7 ROUGHING-IN FOR WATER METERS

A. Rough-in piping and specialties for water meter installation according to utility company's written instructions.

3.8 BACKFLOW PREVENTER INSTALLATION

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

C. Do not install bypass piping around backflow preventers.

D. Support NPS 2-1/2 and larger backflow preventers and piping on concrete piers. Comply with requirements for concrete piers in Division 03 Section "Cast-in-Place Concrete Miscellaneous Cast-in-Place Concrete."

3.9 FIRE-DEPARTMENT CONNECTION INSTALLATION

A. Install ball drip valves at each check valve for fire-department connection to mains.

B. Install protective pipe bollards on two sides of each fire-department connection. Pipe bollards are specified in Division 05 Section "Metal Fabrications."

3.10 ALARM DEVICE INSTALLATION

A. General: Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.

B. Supervisory Switches: Supervise valves in open position.

1. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.

2. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.

C. Locking and Sealing: Secure unsupervised valves as follows:

1. Valves: Install chain and padlock on open OS&Y gate valve.

2. Post Indicators: Install padlock on wrench on indicator post.

D. Pressure Switches: Drill and thread hole in exposed barrel of fire hydrant. Install switch.

E. Water-Flow Indicators: Install in water-service piping in vault. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.

F. Connect alarm devices to building's fire-alarm system. Wiring and fire-alarm devices are specified in Division 28 Sections.

3.11 CONNECTIONS

A. Connect fire-suppression water-service piping to utility water main. Use tapping sleeve and tapping valve service clamp and corporation valve.

B. Connect fire-suppression water-service piping to interior fire-suppression piping.

C. Connect waste piping from concrete vault drains to storm-drainage system. Comply with requirements in Division 33 Section "Storm Utility Drainage Piping" for connection to storm sewer.

3.12 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in exterior walls.

1. Exception: Sleeves are not required for core-drilled holes.

B. Cut sleeves to length for mounting flush with both surfaces.

C. Install sleeves in new floor slabs and walls as they are constructed.

D. For exterior wall penetrations above grade, seal annular space between sleeves and piping using sleeve seals.

E. For exterior wall penetrations below grade, seal annular space between sleeves and piping using sleeve seals.

F. Seal space outside of sleeves in concrete walls with grout.

G. Install the following sleeve materials:

1. Galvanized- steel pipe sleeves for pipes smaller than NPS 6.

2. Cast-iron wall-pipe sleeves for pipes NPS 6 and larger.

3.13 SLEEVE SEAL INSTALLATION

A. Install sleeve seals in sleeves in exterior concrete floor slabs and walls at fire-suppression water-service piping entries into the building.

B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.14 FIELD QUALITY CONTROL

A. Use test procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described below.

B. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

C. Hydrostatic Tests: Test at not less than one-and-one-half times the working pressure for two hours.

1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for one hour; decrease to 0 psig. Slowly increase again to test pressure and hold for one more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

D. Prepare test and inspection reports.

3.15 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground fire-suppression water-service piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Division 31 Section "Earth Moving."

B. Permanently attach equipment nameplate or marker indicating plastic fire-suppression water-service piping or fire-suppression water-service piping with electrically insulated fittings, on main electrical meter panel. Comply with requirements for identifying devices in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.16 CLEANING

A. Clean and disinfect fire-suppression water-service piping as follows:

1. Purge new piping systems and parts of existing systems that have been altered, extended, or repaired before use.

2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.

3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.

b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for three hours.

c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.

d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 211100

SECTION 211200 - FIRE-SUPPRESSION STANDPIPES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fire-protection valves.

B. Related Sections:

1. Division 21 Section "Wet-Pipe Sprinkler Systems" for wet-pipe sprinkler piping.

4. Division 21 Section "Electric-Drive, Centrifugal Fire Pumps" for fire pumps, pressure- maintenance pumps, and fire-pump controllers.

1.3 DEFINITIONS

A. High-Pressure Standpipe Piping: Fire-suppression standpipe piping designed to operate at working pressure higher than standard 175 psig, but not higher than 300 psig.

B. Standard-Pressure Standpipe Piping: Fire-suppression standpipe piping designed to operate at working pressure 175 psig maximum.

1.4 SYSTEM DESCRIPTION

A. Automatic Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 hose connections. Has open water-supply valve with pressure maintained and is capable of supplying water demand.

B. Automatic Wet-Type, Class II Standpipe System: Includes NPS 1-1/2 hose stations. Has open water-supply valve with pressure maintained and is capable of supplying water demand.

C. Automatic Wet-Type, Class III Standpipe System: Includes NPS 1-1/2 hose stations and NPS 2-1/2 hose connections. Has open water-supply valve with pressure maintained and is capable of supplying water demand.

1.5 PERFORMANCE REQUIREMENTS

A. Standard-Pressure, Fire-Suppression Standpipe System Component: Listed for 175-psig minimum working pressure.

C. Delegated Design: Design fire-suppression standpipes, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

D. Fire-suppression standpipe design shall be approved by authorities having jurisdiction.

1. Minimum residual pressure at each hose-connection outlet is as flows:

a. NPS 1-1/2 Hose Connections: 65 psig.

b. NPS 2-1/2 Hose Connections: 100 psig.

2. Maximum residual pressure at required flow at each hose-connection outlet is as follows unless otherwise indicated:

a. NPS 1-1/2 Hose Connections: 100 psig.

b. NPS 2-1/2 Hose Connections: 175 psig.

E. Seismic Performance: Fire-suppression standpipes shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Fire-Suppression Standpipe Service: Do not interrupt fire-suppression standpipe service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fire-suppression standpipe service according to requirements indicated:

1. Do not proceed with interruption of fire-suppression standpipe service without Architect's, Construction Manager's, Owner's and Engineer’s written permission.

PART 2 - PRODUCTS

2.1 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating:
   a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.
   b. High-Pressure Piping Specialty Valves: 250 psig minimum.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Pressure-Reducing Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide by one of the following:
   a. AFAC Inc.
   b. Elkhart Brass Mfg. Company, Inc.
   c. Fire-End & Croker Corporation.
   d. Fire Protection Products, Inc.
   e. GMR International Equipment Corporation.
   f. Guardian Fire Equipment, Inc.
   g. Potter Roemer.
   h. Tyco Fire & Building Products LP.
   i. Wilson & Cousins Inc.
   j. Zurn Plumbing Products Group; Wilkins Water Control Products Division.
2. UL 668 hose valve, with integral UL 1468 reducing device.
3. Pressure Rating: 300 psig minimum.
4. Material: Brass or bronze.
5. Inlet: Female pipe threads.
6. Outlet: Threaded with or without adapter having male hose threads.
7. Pattern: Angle or gate.

8. Finish: Polished chrome plated or Rough brass or bronze.

PART 3 - EXECUTION

3.1 WATER-SUPPLY CONNECTIONS

A. Connect fire-suppression standpipe piping to building's interior water-distribution piping. Comply with requirements for interior piping in Division 22 Section "Domestic Water Piping."

3.2 VALVE AND SPECIALTIES INSTALLATION

A. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
2. Orifice Plate: Install to meet a maximum of 100 psi.
3. Pressure regulating valves: installed to meet maximum of 175 psi at each floor.

END OF SECTION 211200

SECTION 211313 - SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. SECTION INCLUDES:
1. Wet pipe sprinkler system.
2. System design, installation, and certification.
3. Fire department connections.

B. RELATED SECTIONS
1. Division 2 - Trenching.
2. Section 230548 - Vibration Isolation.
3. Section 230553 - Mechanical Identification.
4. Section 262800 - Wiring Connections.

1.2 REFERENCES

A. NFPA 13 - Installation of Sprinkler Systems.

B. FM - Factory Mutual Approval Guide.

C. NFPA 70 - National Electrical Code.

D. UL - Fire Resistance Directory.

E. UL 199 - Automatic Sprinklers.

1.3 SYSTEM DESCRIPTION

A. System to provide coverage for entire building.

B. Provide system to NFPA 13 light hazard.

C. Determine volume and pressure of incoming water supply from water flow test data. Coordinate with site engineer.

D. Interface system with building fire and smoke alarm system.

E. Provide fire department connections. Coordinate location with project engineer and local fire department.

1.4 SUBMITTALS FOR REVIEW

A. Division 1 - Submittals: Procedures for submittals.

B. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

C. Shop Drawings:

1. Submit preliminary layout of finished ceiling areas indicating only sprinkler locations coordinated with ceiling installation. Design engineer shall coordinate layout of all sprinkler heads with project architect and engineer.
2. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components and accessories. Indicate system controls.

D. Submit shop drawings, product data, and hydraulic calculations to engineer for approval, authority having jurisdiction for approval, Owner's insurance underwriter for approval. Submit proof of approval to Engineer.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

A. Division 1 - Contract Closeout: Operation and Maintenance Data, Warranties: Procedures for submittals.

B. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

C. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds all NFPA, L&I and BOCA code requirements.

D. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

E. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 13.

B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

C. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience.

D. Design entire system under direct supervision of a NICET certified sprinkler designer or registered engineer experienced in design of this Work.

1.7 REGULATORY REQUIREMENTS

A. Conform to UL and FM.

B. Perform Work in accordance with NFPA 13.

C. Equipment and Components: Bear UL or FM label or marking.

D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.8 PRE-INSTALLATION MEETING

A. Division 1 - Coordination and Meetings: Pre-installation meeting.

B. Convene two weeks before starting work of this section.

1.9 DELIVERY, STORAGE, AND PROTECTION

A. Division 1 - Material and Equipment: Transport, handle, store, and protect products.

B. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.10 EXTRA MATERIALS

A. Division 1 - Contract Closeout, Operation and Maintenance Data.

B. Provide extra sprinklers under provisions of NFPA 13.

C. Provide suitable wrenches for each sprinkler type.

D. Provide metal storage cabinet adjacent to alarm valve.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. GEM.

B. Other Acceptable Manufacturers:
1. Central.
2. Star.

C. Division 1 - Material and Equipment: Product options Substitutions: Not permitted.

2.2 SPRINKLERS

A. Suspended Drywall or Lay-In Ceiling:
1. Manufacturers:
a. GEM Model F976.
b. Equal by Central.
c. Equal by Star.
2. Type: Concealed pendant type.
3. Finish: Enamel cap color by Architect.
4. Fusible Link: Fusible solder link, temperature rated for specific area hazard (165 degrees min.). Provide 212 degree solder links in areas not air conditioned and in accordance with the NFPA 13.

B. Exposed Area Type:
1. Manufacturers:
a. GEM Model F950.
b. Equal by Central.
c. Equal by Star.
2. Type: Standard upright type with guard.
3. Finish: Brass.
4. Fusible Link: Fusible solder link with temperature rated for specific area hazard (165 degrees min.). Provide 212 degree solder links in areas not air conditioned in accordance with NFPA 13, and where shown on the drawings.

C. Sidewall Type:
1. Manufacturers:
a. GEM Model F950.

b. Equal by Central.
c. Equal by Star.

2. Type: Standard horizontal sidewall type with matching push on escutcheon plate and guard.
3. Finish: Chrome plated.
4. Escutcheon Plate Finish: Chrome plated.
5. Fusible Link: Fusible solder link type with temperature rated for specific area hazard (165 degrees min.). Provide 212 degree solder links in areas not air conditioned in accordance with NFPA 13, and where shown on the drawings.

2.3 PIPING SPECIALTIES

A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm and electric alarm, with pressure retard chamber and variable pressure trim with test and drain valve. GEM F20 or equal.

B. Electric Alarm: Per fire alarm engineer.

C. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts.

D. Fire Department Connections:
1. Type: Flush mounted wall type with brass finish.
2. Outlets: Two way with thread size to suit fire department hardware; threaded dust cap and chain of matching material and finish.
3. Drain: 3/4 inch automatic drip.
4. Label: "Sprinkler/Standpipe - Fire Department Connection".

E. Supervisory Switches: As manufactured by GEM or equal. Provide flow switches for each system and on a floor-by-floor basis for sprinkler system. Provide tamper switches on all valves.

F. Double detector check with bypass meter. Watts 709DCDA.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with NFPA 13.

B. Install equipment in accordance with manufacturer’s instructions.

C. Provide approved double check valve backflow preventer with bypass meter assembly at sprinkler system water source connection.

D. Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent siamese connectors to allow full swing of fire department wrench handle.

E. Place pipe runs to minimize obstruction to other work.

F. Place piping in concealed spaces above finished ceilings.

G. Center sprinklers in two directions in ceiling tile and provide piping offsets as required.

H. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting.

I. Flush entire piping system of foreign matter.

J. Install guards on exposed sprinklers (refer to drawings for specific locations).

K. Hydrostatically test entire system.

L. Require test be witnessed by authority having jurisdiction.

M. Provide a working drain for all inspector’s test locations.

3.2 INTERFACE WITH OTHER PRODUCTS

A. Ensure required devices are installed and connected as required to fire alarm system.

3.3 SCHEDULES

A. System Hazard Areas – Refer to drawings.

END OF SECTION 211313

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

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.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Plumbing demolition.
9. Equipment installation requirements common to equipment sections.
10. Painting and finishing.
11. Concrete bases.
12. Supports and anchorages.

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, crawlspaces, 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.

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

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. 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.
4. Escutcheons.

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.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. 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.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

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. Manufacturers: Subject to compliance with requirements, provide products by 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. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

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

H. 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.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

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:

a. Cascade Waterworks Mfg. Co.
b. Dresser Industries, Inc.; DMD Div.
c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
d. JCM Industries.
e. Smith-Blair, Inc.
f. Viking Johnson.

2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type 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.

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.

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.

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:

a. Cascade Waterworks Mfg. Co.
b. Fernco, Inc.

c. Mission Rubber Company.
d. Plastic Oddities, Inc.
e. Insert manufacturer's name.

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.
c. Eclipse, Inc.
d. Epco Sales, Inc.
e. Hart Industries, International, Inc.
f. Watts Industries, Inc.; Water Products Div.
g. 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.
d. Watts Industries, Inc.; Water Products Div.

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 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Available Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

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

2.7 SLEEVES

A. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends and a welded steel water stop, unless otherwise indicated.

B. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

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

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

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 cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING 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 free of sags and bends.

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

J. Install piping to allow application of insulation.

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

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. 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 with spring clips.
    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, stamped-steel type with set screw.
    h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

2. Existing Piping: Use the following:

    a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
    b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
    c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
    d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
    e. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated finish.
    f. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
    g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

    a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
    b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
    c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

        1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using 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.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

T. Verify final equipment locations for roughing-in.

U. 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. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. 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.

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

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

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Nonpressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

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

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 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.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings 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. Extend grease fittings to accessible locations.

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

3.6 PAINTING

A. Painting of plumbing systems, equipment, 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.

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 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of 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. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "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.

3.9 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 grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 220500

SECTION 220516 - EXPANSION FITTINGS AND LOOPS 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. Flexible-hose packless expansion joints.
2. Metal-bellows packless expansion joints.
3. Rubber packless expansion joints.
4. Grooved-joint expansion joints.
5. Pipe loops and swing connections.
6. Alignment guides and anchors.

1.3 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

1.4 SUBMITTALS

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

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

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

C. Welding certificates.

D. Product Certificates: For each type of expansion joint, from manufacturer.

E. Maintenance Data: For expansion joints to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 PACKLESS EXPANSION JOINTS

A. Flexible-Hose Packless Expansion Joints:

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. Flex-Hose Co., Inc.
b. Flexicraft Industries.
c. Flex Pression Ltd.
d. Metraflex, Inc.
e. Unisource Manufacturing, Inc.

2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.

a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.

5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.

a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.

6. Expansion Joints for Steel Piping NPS 2 and Smaller: Stainless-steel fittings with threaded end connections.

a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.

7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Stainless-steel fittings with flanged end connections.

a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.

8. Expansion Joints for Steel Piping NPS 8 to NPS 12: Stainless-steel fittings with flanged end connections.

a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F and 90 psig at 600 deg F ratings.

B. Metal-Bellows Packless Expansion Joints:

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. Adsco Manufacturing LLC.
b. American BOA, Inc.
c. Badger Industries, Inc.
d. Expansion Joint Systems, Inc.
e. Flex-Hose Co., Inc.
f. Flexicraft Industries.
g. Flex Pression Ltd.
h. Flex-Weld, Inc.
i. Flo Fab inc.
j. Hyspan Precision Products, Inc.
k. Metraflex, Inc.
l. Proco Products, Inc.
m. Senior Flexonics Pathway.
n. Tozen Corporation.
o. Unaflex.
p. Unisource Manufacturing, Inc.
q. Universal Metal Hose; a subsidiary of Hyspan Precision Products, Inc.
r. U.S. Bellows, Inc.
s. WahlcoMetroflex.

2. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
3. Type: Circular, corrugated bellows with external tie rods.
4. Minimum Pressure Rating: 150 psig unless otherwise indicated.
5. Configuration: Single joint with base and double joint with base class(es) unless otherwise indicated.
6. Expansion Joints for Copper Tubing: Single- or multi-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.

a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint.
b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Solder joint or threaded.
c. End Connections for Copper Tubing NPS 5 and Larger: Flanged.

C. Rubber Packless Expansion Joints:

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. Amber/Booth Company, Inc.; a div. of Vibration Isolation Products of Texas, Inc.
b. Flex-Hose Co., Inc.
c. Flexicraft Industries.
d. Flex-Weld, Inc.
e. Garlock Sealing Technologies.
f. General Rubber Corporation.
g. Mason Industries, Inc.; Mercer Rubber Co.
h. Metraflex, Inc.
i. Proco Products, Inc.

j. Red Valve Company, Inc.
k. Tozen Corporation.
l. Unaflex.
m. Unisource Manufacturing, Inc.

2. Standards: ASTM F 1123 and FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
3. Material: Fabric-reinforced rubber complying with FSA-NMEJ-703.
4. Arch Type: Single or multiple arches with external control rods.
5. Spherical Type: Single or multiple spheres with external control rods.
6. Minimum Pressure Rating for NPS 1-1/2 to NPS 4: 150 psig at 220 deg F.
7. Minimum Pressure Rating for NPS 5 and NPS 6: 140 psig at 200 deg F.
8. Minimum Pressure Rating for NPS 8 to NPS 12: 140 psig at 180 deg F.
9. Material for Fluids Containing Acids, Alkalies, or Chemicals: EPDM.
10. Material for Fluids Containing Gas, Hydrocarbons, or Oil: CR.
11. Material for Water: BR.
12. End Connections: Full-faced, integral steel flanges with steel retaining rings.

2.2 GROOVED-JOINT EXPANSION JOINTS

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. Anvil International, Inc.
2. Shurjoint Piping Products.
3. Victaulic Company.

B. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.

C. Standard: AWWA C606, for grooved joints.

D. Nipples: ASTM A 53/A 53M, Schedule 40, Type E or S, steel pipe with grooved ends.

E. Couplings: Five, flexible type for steel-pipe dimensions. Include ferrous housing sections, EPDM gasket suitable for cold and hot water, and bolts and nuts.

2.3 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

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. Adsco Manufacturing LLC.
b. Advanced Thermal Systems, Inc.
c. Flex-Hose Co., Inc.
d. Flexicraft Industries.
e. Flex-Weld, Inc.
f. Hyspan Precision Products, Inc.
g. Metraflex, Inc.
h. Senior Flexonics Pathway.
i. Unisource Manufacturing, Inc.
j. U.S. Bellows, Inc.

2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

    a. Stud: Threaded, zinc-coated carbon steel.
    b. Expansion Plug: Zinc-coated steel.
    c. Washer and Nut: Zinc-coated steel.

5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

    a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
    b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
    c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

C. Install rubber packless expansion joints according to FSA-NMEJ-702.

D. Install grooved-joint expansion joints to grooved-end steel piping

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.

C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.

D. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Black-Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Anchor Attachment to Galvanized-Steel Pipe: Attach with pipe hangers. Use MSS SP-69, Type 42, riser clamp welded to anchor.
3. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 220516

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. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

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

E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

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

G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

A. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

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

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

2.4 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

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

C. Design Mix: 5000-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 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

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

3.3 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.

3.4 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 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] [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] [and] [exposed-rivet] 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[or split-casting brass] type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type[or split-plate, stamped-steel type with concealed hinge] [or split-plate, stamped-steel type with exposed-rivet hinge].
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass[or split-casting brass] type with polished, chrome-plated finish.
e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type[or split-plate, stamped-steel type with concealed hinge] [or split-plate, stamped-steel type with exposed-rivet hinge].
f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass[or split-casting brass] type with polished, chrome-plated finish.
g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type[or split-plate, stamped-steel type with concealed hinge] [or split-plate, stamped-steel type with exposed-rivet hinge].
h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass[or split-casting brass] type with [polished, chrome-plated] [rough-brass] finish.
i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type[or split-plate, stamped-steel type with concealed hinge] [or split-plate, stamped-steel type with exposed-rivet hinge].
j. Bare Piping in Equipment Rooms: One-piece, cast-brass[or split-casting brass] type with [polished, chrome-plated] [rough-brass] finish.
k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type[or split-plate, stamped-steel type with concealed hinge] [or split-plate, stamped-steel type with exposed-rivet hinge].

2. Escutcheons for Existing Piping:

a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
b. Insulated Piping: Split-plate, stamped-steel type with [concealed] [or] [exposed-rivet] hinge.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with [concealed] [or] [exposed-rivet] hinge.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with [concealed] [or] [exposed-rivet] hinge.
g. Bare Piping in Unfinished Service Spaces: Split-casting brass type with [polished, chrome-plated] [rough-brass] finish.
h. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with [concealed] [or] [exposed-rivet] hinge.
i. Bare Piping in Equipment Rooms: Split-casting brass type with [polished, chrome-plated] [rough-brass] finish.

j. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with [concealed] [or] [exposed-rivet] hinge.

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.
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 220518

SECTION 230523 - PLUMBING VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Ball valves.
2. Butterfly valves.
3. Swing check valves.
4. Spring loaded check valves.
5. Water pressure reducing valves.
6. Relief valves.
7. Flanges, unions, and couplings.

B. Related Sections:
1. Section 230529 - Hangers and Supports: Product and installation requirements for pipe hangers and supports.
2. Section 230700 - Mechanical Insulation: Product and installation requirements for insulation for piping and valves.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI Z21.22 - Relief Valves for Hot Water Supply Systems.

B. American Society of Mechanical Engineers:
1. ASME Section IV - Boiler and Pressure Vessel Code - Heating Boilers.
2. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

C. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.

D. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 67 - Butterfly Valves.
2. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
3. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
4. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
5. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
6. MSS SP 85 - Cast Iron Globe & Angle Valves, Flanged and Threaded.
7. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 SUBMITTALS

A. Division 1 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit Manufacturers catalog information with valve data and ratings for each service.

C. Welders Certificate: Include welders certification of compliance with ASME Section IX.

D. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Division 1 - Execution Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of valves.

C. Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with all local codes and standards.

B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Division 1 - Product Requirements: Product storage and handling requirements.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Division 1 - Product Requirements.

1.9 WARRANTY

A. Division 1 - Execution Requirements: Product warranties and product bonds.

B. Furnish 1 year manufacturer warranty for valves excluding packing.

1.10 EXTRA MATERIALS

A. Division 1 - Execution Requirements: Spare parts and maintenance products.

B. Furnish two packing kits for each size valve.

PART 2 PRODUCTS

2.1 PLUMBING VALVES

A. Ball Valves:

1. Manufacturers:
   a. Nibco.
   b. Watts.
   c. Apollo.
   d. Substitutions: Division 1 - Product Requirements.

2. Furnish materials in accordance with local codes and standards.

3. 2” and Smaller: MSS SP 110, Class 150, 600 psibronze, two piece body, chrome plated brass ball, full port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder ends.

B. Butterfly Valves:

1. Manufacturers:
   a. Nibco.
   b. Watts.
   c. Stockham.
   d. Substitutions: Division 1 - Product Requirements.

2. Furnish materials in accordance with all local codes and standards.

3. 2-1/2” and Larger: MSS SP 67, 200 psi, cast or ductile iron body. Nickel-plated ductile iron disc, resilient replaceable EPDM seat, grooved ends, extended neck, infinite position lever handle with memory stop. Furnish gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.

C. Swing Check Valves:

1. Manufacturers:
   a. Nibco.
   b. Watts.
   c. American Valve.
   d. FMC Crosby Valve.
   e. Substitutions: Division 1 - Product Requirements.
2. Furnish materials in accordance with all local codes and standards.
3. 2 inches and Smaller: MSS SP 80, Class 125, bronze body and cap, bronze swing disc with rubber seat, solder ends.
4. 2-1/2 inches and Larger: MSS SP 71, Class 125, iron body, bronze swing disc, renewable disc seal and seat, flanged ends.

D. Spring Loaded Check Valves:
1. Manufacturers:
   a. Nibco.
   b. Watts.
   c. Substitutions: Division 1 - Product Requirements.
2. Construction: Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer or threaded lug ends.

E. Water Pressure Reducing Valves:

1. Manufacturers:
   a. Watts.
   b. Substitutions: Division 1 - Product Requirements.
2. 2 inches and Smaller: Construction: MSS SP 80, bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, and single union ends.
3. 2-1/2 inches and Larger: MSS SP 85, cast iron body, bronze fitted, elastomeric diaphragm and seat disc, flanged.

F. Relief Valves:
1. Pressure Relief:
   a. Manufacturers:
      1) Watts.
      2) Substitutions: Division 1 - Product Requirements.
   b. Construction: AGA Z21.22 certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.
2. Temperature and Pressure Relief:
   a. Manufacturers:
      1) Watts.
      2) Substitutions: Division 1 - Product Requirements
   b. Construction: ANSI Z21.22 certified, bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, capacity ASME Section IV certified and labeled.

2.2 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe 2 inches and Smaller:
1. Ferrous Piping: 150 psig malleable iron, threaded.
2. Copper Pipe: Bronze, soldered joints.

B. Flanges for Pipe 2 inches and Larger:
1. Ferrous Piping: 150 psig forged steel, slip-on.
2. Copper Piping: Bronze.

C. Gaskets: 1/16-inch thick preformed neoprene.

D. Accessories: Steel bolts, nuts, and washers.

E. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 1 - Administrative Requirements: Coordination with project conditions.

B. Verify piping system is ready for installation.

3.2 INSTALLATION

A. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

B. Install valves with stems upright or horizontal, not inverted.

C. Use grooved mechanical couplings and fasteners only in accessible locations.

D. Install unions downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

E. Install ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.

F. Install ball or butterfly valves for throttling, bypass, or manual flow control services.

G. Provide spring loaded check valves on discharge of water pumps.

H. Use lug end butterfly valves to isolate equipment.

I. Use 3/4 inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

J. Provide plug valves in natural gas systems for shut-off service.

K. Provide flow controls in water re-circulating systems as indicated on Drawings.

L. Refer to Section 230700 for insulation requirements for piping and valves.

M. Refer to Section 230529 for pipe hangers.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe hangers and supports.
   2. Hanger rods.
   3. Inserts.
   4. Flashing.
   5. Sleeves.
   6. Mechanical sleeve seals.
   7. Firestopping relating to mechanical work.
   8. Firestopping accessories.
   9. Equipment bases and supports.

B. Related Sections:
   1. Section 230548 - Mechanical Sound, Vibration, and Seismic Control: Product and execution requirements for vibration isolators.
   2. Section 232113 - Heating and Cooling Piping: Execution requirements for placement of hangers and supports specified by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
   1. ASME B31.9 - Building Services Piping.

B. American Society for Testing and Materials:
   1. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

C. American Welding Society:
   1. AWS D1.1 - Structural Welding Code - Steel.

D. Factory Mutual System:
   1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:
   1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
   2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
   3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

F. Underwriters Laboratories Inc.:
   1. UL 263 - Fire Tests of Building Construction and Materials.
   2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
   3. UL 1479 - Fire Tests of Through-Penetration Firestops.
   4. UL - Fire Resistance Directory.

G. Warnock Hersey:
   1. WH - Certification Listings.

1.3 DEFINITIONS

A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.4 SYSTEM DESCRIPTION

A. Firestopping Materials: ASTM E119, ASTM E814, UL 263, UL 1479, to achieve fire ratings of adjacent construction.

B. Surface Burning: ASTM E84, UL 723 with maximum flame spread / smoke developed rating of 25/450.

C. Firestop interruptions to fire rated assemblies, materials, and components.

1.5 PERFORMANCE REQUIREMENTS

A. Firestopping: Conform to applicable code for fire resistance ratings and surface burning characteristics.

1.6 SUBMITTALS

A. Division 1 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.

C. Product Data:
1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
2. Firestopping: Submit data on product characteristics, performance and limitation criteria.

D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Manufacturer's Installation Instructions:
1. Hangers and Supports: Submit special procedures and assembly of components.
2. Firestopping: Submit preparation and installation instructions.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with all local codes and standards.

B. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Division 1 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Division 1 - Product Requirements: Environmental conditions affecting products on site.

B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.

C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

D. Provide ventilation in areas to receive solvent cured materials.

1.11 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.12 WARRANTY

A. Division 1 - Execution Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for pipe hangers and supports.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:
   1. B-Line.
   2. Grinnell.
   3. Substitutions: Division 1 - Product Requirements.

B. Furnish materials in accordance with all applicable codes and standards.

C. Plumbing Piping - DWV:
   1. Conform to ASME B31.9; ASTM F708.
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
   3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
   4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   5. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
   6. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
   7. Vertical Support: Steel riser clamp.

8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Copper-plated, carbon-steel adjustable, ring.

D. Plumbing Piping - Water:
1. Conform to ASME B31.9; ASTM F708.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 inches and Larger: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
9. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 inches and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 4 inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Copper-plated, Carbon-steel ring.

E. Copper Pipe Support: Copper-plated carbon-steel ring.

2.2 ACCESSORIES

A. Hanger Rods: Steel threaded both ends, threaded on one end, or continuous threaded.

2.3 INSERTS

A. Manufacturers:
1. Grinnell.
2. B-line.
3. Substitutions: Division 1 - Product Requirements.

B. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

A. Refer to roofing specifications.

2.5 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

2.6 FIRESTOPPING

A. Manufacturers:
   1. Dow Corning Corp.
   2. 3M fire Protection Products.
   3. Substitutions: Division 1 - Product Requirements.

B. Furnish materials in accordance with all local codes and standards.

C. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
   1. Silicone Firestopping Elastomeric Firestopping: Single component silicone elastomeric compound and compatible silicone sealant.
   2. Foam Firestopping Compounds: Single component foam compound.
   3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
   4. Fiber Stuffing and Sealant Firestopping: Composite of mineral fiber stuffing insulation with silicone elastomer for smoke stopping.
   5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
   6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
   7. Firestop Pillows: Formed mineral fiber pillows.

2.7 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Dam Material: Permanent:
   1. Mineral fiberboard.
   2. Mineral fiber matting.

C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

D. General:
   1. Furnish UL listed products.
   2. Select products with rating not less than rating of wall or floor being penetrated.

E. Non-Rated Surfaces:
   1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
   2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve, link-seal or approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 1 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify openings are ready to receive sleeves.

C. Verify openings are ready to receive firestopping.

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Obtain permission from Engineer before using powder-actuated anchors.

D. Do not drill or cut structural members.

E. Obtain permission from Engineer before drilling or cutting structural members.

3.3 INSTALLATION - INSERTS

A. Install inserts for placement in concrete forms.

B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.1; ASME B31.5; ASME 31.9; ASTM F708.

B. Support horizontal piping as scheduled. If not scheduled, support in accordance with the International Mechanical Code.

C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Use hangers with 1-1/2 inch minimum vertical adjustment.

F. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

G. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

H. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.

I. Support riser piping independently of connected horizontal piping.

J. Provide copper plated hangers and supports for copper piping.

K. Design hangers for pipe movement without disengagement of supported pipe.

L. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

M. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 230700.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 4” thick and extending 6 inches beyond supported equipment.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Provide rigid anchors for pipes after vibration isolation components are installed. Refer to Section 230548.

3.6 INSTALLATION – FLASHING

A. All roof work shall be performed in strict accordance with the roofing contractor’s requirements. On new or warranted work MC shall pay the roofing contractor to perform all of his roof work.

B. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

C. Flash vent and soil pipes projecting 12 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal.

D. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.

E. Seal floor drains watertight to adjacent materials.

F. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms for sound control.

G. Provide curbs for mechanical roof installations 14 inches minimum high above roofing surface. Flash and counter-flash with sheet metal; seal watertight. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.

H. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.7 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with mechanical sleeve seals.

B. Set sleeves in position in forms. Provide reinforcing around sleeves.

C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.

E. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

F. Install stainless steel escutcheons at finished surfaces.

3.8 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items, requiring firestopping.

B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating.

D. Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.

E. Place intumescent coating in sufficient coats to achieve rating required.

F. Fire Rated Surface:
1. Seal opening at floor, wall, partition, ceiling, and roof as follows:
    a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
    b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
    c. Pack void with backing material.
    d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
2. Where conduit, and penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.

G. Non-Rated Surfaces:
1. Seal opening through non-fire rated wall, partition, floor, ceiling, and roof opening as follows:
    a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
    b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
    c. Install type of firestopping material recommended by manufacturer.
2. Install escutcheons where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
3. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.

3.9 FIELD QUALITY CONTROL

A. Division 1 - Quality Requirements, 014000 - Execution Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.10 CLEANING

A. Division 1 - Execution Requirements: Requirements for cleaning.

B. Clean adjacent surfaces of firestopping materials.

3.11 PROTECTION OF FINISHED WORK

A. Division 1 - Execution Requirements: Requirements for protecting finished Work.

B. Protect adjacent surfaces from damage by material installation.

3.12 SCHEDULES

PIPE HANGER SPACING – Steel, Cast Iron or Copper Unless Noted.

PIPE SIZE (Inches)	MAX. HANGER SPACING (Feet)	HANGER ROD DIAMETER (Inches)
1/2	8	3/8
3/4	8	3/8
1	8	3/8
1-1/4	8	3/8
1-1/2	10	3/8
2	10	3/8
2-1/2	12	1/2
3	12	1/2
4	12	5/8
5	12	5/8
6	12	3/4
8	12	3/4
10	12	7/8
12	12	7/8
Spigot or No-Hub	5	5/8

And at Joints

END OF SECTION 230529

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. Domestic chilled-water piping for drinking fountains.
5. Sanitary waste piping exposed to freezing conditions.
6. Storm-water piping exposed to freezing conditions.
7. Roof drains and rainwater leaders.
8. Supplies and drains for handicap-accessible lavatories and sinks.

B. Related Sections:

1. Section 220716 "Plumbing Equipment Insulation."

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).

B. Sustainable Design Submittals:

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
2. Jacket Materials for Pipe: 12 inches long by NPS 2.
3. Sheet Jacket Materials: 12 inches square.

4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

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. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Piping Mockups:

    a. One 10-foot section of NPS 2 straight pipe.
    b. One each of a 90-degree threaded, welded, and flanged elbow.
    c. One each of a threaded, welded, and flanged tee fitting.
    d. One NPS 2 or smaller valve, and one NPS 2-1/2 or larger valve.
    e. Four support hangers including hanger shield and insert.
    f. One threaded strainer and one flanged strainer with removable portion of insulation.
    g. One threaded reducer and one welded reducer.
    h. One pressure temperature tap.
    i. One mechanical coupling.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.

5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

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

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

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.

C. Coordinate installation and testing of heat tracing.

1.8 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.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Block Insulation: ASTM C 552, Type I.
2. Special-Shaped Insulation: ASTM C 552, Type III.
3. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
4. Preformed Pipe Insulation with Factory-Applied [ASJ] [ASJ-SSL]: Comply with ASTM C 552, Type II, Class 2.
5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

H. 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.

I. Mineral-Fiber, Preformed Pipe Insulation:

1. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, [without factory-applied jacket] [with factory-applied ASJ] [with factory-applied ASJ-SSL]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

J. Phenolic:

1. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
2. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
3. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
4. Factory-Applied Jacket: [None] [ASJ]. Requirements are specified in "Factory-Applied Jackets" Article.

K. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

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

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

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. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F .

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

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

E. Phenolic Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

F. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

G. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
   1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180 deg.
   3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
   4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
   2. Service Temperature Range: 0 to 180 deg F.
   3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
   4. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
   2. Service Temperature Range: Minus 50 to plus 220 deg F.
   3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
   4. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180 deg F.
   3. Solids Content: 60 percent by volume and 66 percent by weight.
   4. Color: White.

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. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Color: White.

2.6 SEALANTS

A. Joint Sealants for Cellular-Glass and Phenolic Products:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F .
4. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F .
4. 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. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

2.9 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.

2.10 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. Adhesive: As recommended by jacket material manufacturer.
   2. Color: [White] [Color-code jackets based on system. Color as selected by Architect].
   3. 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.

C. Metal Jacket:
   1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

      a. [Sheet and roll stock ready for shop or field sizing] [Factory cut and rolled to size].
      b. Finish and thickness are indicated in field-applied jacket schedules.
      c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper 3-mil- thick, heat-bonded polyethylene and kraft paper2.5-mil- thick polysurlyn].
      d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper 2.5-mil- thick polysurlyn.
      e. Factory-Fabricated Fitting Covers:

         1) Same material, finish, and thickness as jacket.
         2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         3) Tee covers.
         4) Flange and union covers.
         5) End caps.
         6) Beveled collars.
         7) Valve covers.
         8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

   2. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.

      a. [Sheet and roll stock ready for shop or field sizing] [Factory cut and rolled to size].
      b. Material, finish, and thickness are indicated in field-applied jacket schedules.
      c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper 3-mil- thick, heat-bonded polyethylene and kraft paper 2.5-mil-thick polysurlyn.
      d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper]2.5-mil- thick polysurlyn.
      e. Factory-Fabricated Fitting Covers:

         1) Same material, finish, and thickness as jacket.
         2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         3) Tee covers.
         4) Flange and union covers.
         5) End caps.
         6) Beveled collars.

7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

D. Underground Direct-Buried Jacket: 125-mil- thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

2.11 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: 3 inches
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. 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. Width: 3 inches
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Width: 2 inches.
2. Thickness: 6 mils .
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

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

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

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

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

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

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends 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.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
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 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.

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

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

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

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 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. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. 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, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers 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 POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin 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.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, 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.

D. 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.

3.8 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will 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.

3.10 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.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. NPS 1 and Smaller: Insulation shall be one of the following:
    a. Flexible Elastomeric: 1 inch thick.
    b. Mineral-Fiber, Preformed Pipe Insulation, Type 1 inch thick.
    c. Phenolic: 1 inch thick.
    d. Polyolefin: 1 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. Polyolefin 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.
    b. Phenolic: 1 inch thick.
    c. Polyolefin: 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 inch thick.
    b. Phenolic: 1 inch thick.
    c. Polyolefin: 1 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.
    b. Phenolic: 1 inch thick.
    c. Polyolefin: 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.
    b. Phenolic: 1 inch thick.
    c. Polyolefin: 1 inch thick.

E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation shall be[one of] the following:
    a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
    b. Phenolic: 1 inch thick.
    c. Polyolefin: 1 inch thick.

F. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. All Pipe Sizes: Insulation shall be[one of] the following:
    a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
    b. Phenolic: 1 inch thick.
    c. Polyolefin: 1 inch thick.

END OF SECTION 220719

SECTION 221113 - FACILITY WATER DISTRIBUTION 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 water-distribution piping and related components outside the building for water service and fire-hydrant relocation piping.

B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

1.3 SUBMITTALS

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

B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

1. Wiring Diagrams: Power, signal, and control wiring for alarms.

C. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.

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

C. 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.

D. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

F. NSF Compliance:

1. Comply with NSF 14 for plastic potable-water-service piping. Include marking "NSF-pw" on piping.
2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.
2. Protect valves against damage to threaded ends and flange faces.
3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves, including fire hydrants, according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.6 PROJECT CONDITIONS

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

1. Notify Construction Manager no fewer than three days in advance of proposed interruption of service.
2. Do not proceed with interruption of water-distribution service without Construction Manager's written permission.

1.7 COORDINATION

A. Coordinate connection to water main with utility company.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.

1. Grooved-End, Ductile-Iron Pipe Appurtenances:

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Anvil International, Inc.
2) Victaulic Company of America.

c. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
d. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

C. Flanges: ASME 16.1, Class 125, cast iron.

2.2 SPECIAL PIPE FITTINGS

A. Ductile-Iron Rigid Expansion Joints:

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. EBAA Iron, Inc.
b. U.S. Pipe and Foundry Company.

2. Description: Three-piece, ductile-iron assembly consisting of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

a. Pressure Rating: 250 psig minimum.

b. Expansion Required: 3”

B. Ductile-Iron Deflection Fittings:

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

a. EBAA Iron, Inc.

3. Description: Compound, ductile-iron coupling fitting with sleeve and 1 or 2 flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

a. Pressure Rating: 250 psig minimum.

2.3 JOINING MATERIALS

A. Refer to Division 22 Section "Common Work Results for Plumbing" for commonly used joining materials.

B. Brazing Filler Metals: AWS A5.8, BCuP Series.

C. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

2.4 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Flexible Connectors:

1. Nonferrous-Metal Piping: Bronze hose covered with bronze wire braid; with copper-tube, pressure-type, solder-joint ends or bronze flanged ends brazed to hose.
2. Ferrous-Metal Piping: Stainless-steel hose covered with stainless-steel wire braid; with ASME B1.20.1, threaded steel pipe nipples or ASME B16.5, steel pipe flanges welded to hose.

C. Dielectric Fittings: Combination of copper alloy and ferrous; threaded, solder, or plain end types; and matching piping system materials.

1. Dielectric Unions: Factory-fabricated union assembly, designed for 250-psig minimum working pressure at 180 deg F. Include insulating material that isolates dissimilar metals and ends with inside threads according to ASME B1.20.1.
2. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure to suit system pressures.
3. Dielectric-Flange Insulation Kits: Field-assembled companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

a. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure to suit system pressures.

4. Dielectric Couplings: Galvanized-steel couplings with inert and noncorrosive thermoplastic lining, with threaded ends and 300-psig minimum working pressure at 225 deg F.
5. Dielectric Nipples: Electroplated steel nipples with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved end types, and 300-psig minimum working pressure at 225 deg F.

2.5 GATE VALVES

A. AWWA, Cast-Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Stockham Div.
   b. East Jordan Iron Works, Inc.
   c. Mueller Co.; Water Products Div.
   d. NIBCO INC.

2. Nonrising-Stem, Resilient-Seated Gate Valves:

   a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.

      1) Standard: AWWA C509.
      2) Minimum Pressure Rating: 200 psig.
      3) End Connections: Mechanical joint.
      4) Interior Coating: Complying with AWWA C550.

3. Nonrising-Stem, High-Pressure, Resilient-Seated Gate Valves:

   a. Description: Ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut.

      1) Standard: AWWA C509.
      2) Minimum Pressure Rating: 250 psig.
      3) End Connections: Push on or mechanical joint.
      4) Interior Coating: Complying with AWWA C550.

2.6 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:

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. East Jordan Iron Works, Inc.
   b. Flowserve.
   c. Mueller Co.; Water Products Div.

2. Description: Sleeve and valve compatible with drilling machine.

   a. Standard: MSS SP-60.
   b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.

c. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.

1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

C. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2.7 BUTTERFLY VALVES

A. AWWA Butterfly Valves:

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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. DeZURIK/Copes-Vulcan; a unit of SPX Corporation.
b. Milliken Valve Company.
c. Mosser Valve; a division of Olson Technologies, Inc.
d. Mueller Co.; Water Products Div.
e. Pratt, Henry Company.
f. Val-Matic Valve & Manufacturing Corp.

4. Description: Rubber seated.

a. Standard: AWWA C504.
b. Body: Cast or ductile iron.
c. Body Type: Flanged.
d. Pressure Rating: 150 psig.

B. UL Butterfly Valves:

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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. McWane, Inc.; Kennedy Valve Div.
b. Milwaukee Valve Company.
c. Mueller Co.; Water Products Div.
d. NIBCO INC.
e. Pratt, Henry Company.

4. Description: Metal on resilient material seating.

    a. Standards: UL 1091 and FMG approved.
    b. Body: Cast or ductile iron.
    c. Body Type: Flanged.
    d. Pressure Rating: 175 psig.

2.8 WATER METERS

A. Water meters will be furnished by utility company.

B. Manufacturers:

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. AMCO Water Metering Systems.
    b. Badger Meter, Inc.
    c. Carlon Meter.
    d. Hays Fluid Controls; a division of ROMAC Industries Inc.
    e. McCrometer.
    f. Mueller Co.; Hersey Meters.
    g. Neptune Technology Group Inc.
    h. Sensus Metering Systems.

C. Compound-Type Water Meters:

1. Description:

    a. Standard: AWWA C702.
    b. Registration: Flow in gallons.

2.9 PRESSURE-REDUCING VALVES

A. Water Regulators:

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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

    a. Cash Acme; a division of The Reliance Worldwide Corporation.
    b. Conbraco Industries, Inc.
    c. Honeywell Water Controls.
    d. Watts Water Technologies, Inc.
    e. Zurn Plumbing Products Group; Wilkins Water Control Products Div.

B. Water Control Valves:

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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

    a. CLA-VAL Automatic Control Valves.
    b. Flomatic Corporation.
    c. OCV Control Valves.
    d. Watts Regulator Co.; Ames Fluid Control Systems.
    e. Watts Regulator Co.; Watts ACV Division.
    f. Zurn Plumbing Products Group; Wilkins Water Control Products Div.

4. Description: Pilot-operation, diaphragm-type, single-seated main water control valve with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot control valve, restrictor device, specialty fittings, and sensor piping.

2.10 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

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. Ames Fire & Waterworks; a division of Watts Regulator Co.
    b. Conbraco Industries, Inc.
    c. FEBCO; SPX Valves & Controls.
    d. Flomatic Corporation.
    e. Watts Water Technologies, Inc.
    f. Zurn Plumbing Products Group; Wilkins Water Control Products Div.

B. Backflow Preventer Test 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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Conbraco Industries, Inc.
    b. FEBCO; SPX Valves & Controls.
    c. Flomatic Corporation.
    d. Watts Water Technologies, Inc.
    e. Zurn Plumbing Products Group; Wilkins Water Control Products Div.

3. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.11 FIRE HYDRANTS

A. Dry-Barrel Fire Hydrants:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings. or a comparable product by one of the following:
   a. American Cast Iron Pipe Co.; American Flow Control Div.
   b. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
   c. East Jordan Iron Works, Inc.
   d. Mueller Co.; Water Products Div.

2. Description: Freestanding, with one NPS 4-1/2 and two NPS 2-1/2 outlets, 5-1/4-inch (main valve, drain valve, and NPS 6 mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.

   a. Standard: AWWA C502.
   b. Pressure Rating: 150 psig minimum.
   c. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
   d. Operating and Cap Nuts: Pentagon, 1-1/2 inches point to flat.
   e. Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
   f. Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.

B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

C. Do not use flanges or unions for underground piping.

D. Underground water-service piping NPS 4 to NPS 8 shall be the following:
   1. Ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.

E. Aboveground water-service piping NPS 4 to NPS 8 shall be any of the following:

   1. Hard copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and brazed joints.
   2. Ductile-iron, grooved-end pipe; ductile-iron, grooved-end appurtenances; and grooved joints.

3.3 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Underground Valves, NPS 4 and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.
   2. Use the following for valves aboveground:
      a. Gate Valves, NPS 2 and Smaller: Bronze, nonrising stem.
      b. Gate Valves, NPS 3 and Larger: AWWA, cast iron, OS&Y rising stem, resilient seated.
      c. Check Valves: AWWA C508, swing type.

   3. Pressure-Reducing Valves: Use for water-service piping in vaults and aboveground to control water pressure.
   4. Relief Valves: Use for water-service piping in vaults and aboveground.

      a. Air-Release Valves: To release accumulated air.
      b. Air/Vacuum Valves: To release or admit large volume of air during filling of piping.
      c. Combination Air Valves: To release or admit air.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

A. See Division 22 Section "Common Work Results for Plumbing" for piping-system common requirements.

3.5 PIPING INSTALLATION

A. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.

B. Make connections larger than NPS 2 with tapping machine according to the following:

   1. Install tapping sleeve and tapping valve according to MSS SP-60.
   2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
   3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
   4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.

C. Comply with NFPA 24 for fire-service-main piping materials and installation.

D. Bury piping with depth of cover over top at least 30 inches, with top at least 12 inches below level of maximum frost penetration, and according to the following:

   1. Under Parking Lot: With at least 36 inches cover over top.
   2. In Loose Gravelly Soil and Rock: With at least 12 inches additional cover.

E. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.

F. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.

   1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.

G. Sleeves are specified in Division 22 Section "Common Work Results for Plumbing."

H. Mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."

I. See Division 21 Section "Water-Based Fire-Suppression Systems" for fire-suppression-water piping inside the building.

J. See Division 22 Section "Domestic Water Piping" for potable-water piping inside the building.

3.6 JOINT CONSTRUCTION

A. See Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.

B. Make pipe joints according to the following:
   1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.

3.7 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:

   1. Concrete thrust blocks.
   2. Locking mechanical joints.
   3. Set-screw mechanical retainer glands.
   4. Bolted flanged joints.
   5. Heat-fused joints.
   6. Pipe clamps and tie rods.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

   1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
   2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
   3. Bonded-Joint Fiberglass, Water-Service Piping: According to AWWA M45.
   4. Fire-Service-Main Piping: According to NFPA 24.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.8 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. Pressure-Reducing Valves: Install in vault or aboveground between shutoff valves.]

C. Relief Valves: Comply with AWWA C512. Install aboveground with shutoff valve on inlet.

3.9 WATER METER INSTALLATION

A. Install water meters, piping, and specialties according to utility company's written instructions.

B. Water Meters: Install displacement-type water meters, NPS 2 and smaller, with shutoff valves on water meter inlets. Include valves on water meter outlets and valved bypass around meters unless prohibited by authorities having jurisdiction.

3.10 ROUGHING-IN FOR WATER METERS

A. Rough-in piping and specialties for water meter installation according to utility company's written instructions.

3.11 BACKFLOW PREVENTER INSTALLATION

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

C. Do not install bypass piping around backflow preventers.

D. Support NPS 2-1/2 and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

3.12 PROTECTIVE ENCLOSURE INSTALLATION

A. Install concrete base level and with top approximately 2 inches above grade.

B. Install protective enclosure over valves and equipment.

C. Anchor protective enclosure to concrete base.

3.13 FIRE HYDRANT INSTALLATION

A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

B. AWWA Fire Hydrants: Comply with AWWA M17.

C. UL/FMG Fire Hydrants: Comply with NFPA 24.

3.14 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. See Division 22 Section "Common Work Results for Plumbing" for piping connections to valves and equipment.

C. Connect water distribution piping to existing main at curb stop. Use tapping sleeve and tapping valve.

D. Connect water-distribution piping to interior domestic water piping and relocated fire hydrant.

E. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.15 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.

1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

3.16 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Division 31 Section "Earth Moving."

3.17 CLEANING

A. Clean and disinfect water-distribution piping as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

    a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
    b. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
    c. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 221113

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe and pipe fittings.
   2. Domestic water piping system.

B. RELATED SECTIONS
   1. Section 230529 – Hangers and Supports.
   2. Section 230548 - Vibration Isolation.
   3. Section 230700 - Piping Insulation.
   4. Section 224000 - Plumbing Fixtures.
   5. Section 224010 - Plumbing Specialties.
   6. Division 31 – Excavating, Earthwork, Trenching.
   7. Division 8 - Access Doors.
   8. Division 9 - Painting.

1.2 REFERENCES

A. Division 1 - Quality Control

B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.

C. ASME B16.22 - Wrought Copper and Bronze Solder Joint Pressure Fittings.

D. ASME B16.26 - Cast Bronze Fittings for Flared Copper Tubes.

E. ASME B31.9 - Building Service Piping.

F. ASME SEC IV - Construction of Heating Boilers.

G. ASME SEC IX - Welding and Brazing Qualifications.

H. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.

I. ASTM B32 - Solder Metal.

J. ASTM B42 - Seamless Copper Pipe.

K. ASTM B75 - Seamless Copper Tube.

L. ASTM B88 - Seamless Copper Water Tube.

M. ASTM E814 - Fire Tests of Through-Penetration Fire Stops.

N. AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.

O. AWWA C110 - Ductile - Iron and Gray - Iron Fittings 3 in. through 48 in., for Water and Other Liquids.

P. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.

Q. AWWA C651 - Disinfecting Water Mains.

R. UL 1479 - Fire Tests of Through-Penetration Firestops.

1.3 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 1.

B. Maintenance Data: Include installation instructions, spare parts lists.

1.5 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Welding Materials and Procedures: Conform to ASME Code and applicable state regulations.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 5 years experience.

B. Installer: Company specializing in performing the work of this section with minimum 3 years experience.

1.7 REGULATORY REQUIREMENTS

A. Perform Work in accordance with the latest edition of the, BOCA, NFPA and all local codes.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 1.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.1 PE PIPING AND FITTINGS

A. PE, ASTM Pipe: ASTM D 2239, SIDR No. 5.3, 7, or 9; with PE compound number required to give pressure rating not less than 200 psig.

1. Insert Fittings for PE Pipe: ASTM D 2609, made of PA, PP, or PVC with serrated male insert ends matching inside of pipe. Include bands or crimp rings.
2. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify excavations under provisions of Division 1.

B. Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

D. Install piping to maintain headroom, conserve space, and not interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

H. Establish elevations of buried piping outside the building to ensure not less than 4 ft of cover for water lines.

I. Provide support for utility meters in accordance with requirements of utility companies.

J. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Division 9.

K. Excavate and backfill in accordance with Division 2.

L. Install water piping to ASME B31.9.

M. Install foundation drain bedded in a gravel envelope. Gravel bedding shall extend 4" above top of tubing and 4" below bottom of tubing. Install drain line with continuous fall of 0.25" per foot. Use non-perforated tubing for sections where tree roots may be present. Provide geotextile fabric around entire filter bed. Refer to architectural and site engineering documents.

3.4 ERECTION TOLERANCES

A. Establish invert elevations, slopes for drainage per code or as noted on the drawings.

B. Slope water piping and arrange to drain at low points.

3.5 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Prior to starting work, verify system is complete, flushed and clean.

B. Ensure pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

E. Maintain disinfectant in system for 24 hours.

F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

G. Flush disinfectant from system until residual equal to that of incoming water.

H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.6 SERVICE CONNECTIONS

A. Provide new water and fire service complete with approved reduced pressure backflow preventer and water meter. Coordinate service requirements with the local utilities. Pay all permitting fees.
   1. Provide sleeve in wall or floor for service main. Caulk enlarged sleeve and make watertight with pliable material such as link-seal. Anchor service main.

B. All new services shall be coordinated with the local utility companies. Contractor shall pay all permitting fees. Owner will pay the tap and connection fees.

END OF SECTION 221116

SECTION 221313 - FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes gravity-flow, nonpressure sanitary sewerage outside the building, with the following components:
   1. Precast concrete manholes.

1.3 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water .

1.5 SUBMITTALS

A. Shop Drawings: For the following:

   1. Manholes: Include plans, elevations, sections, details, and frames and covers

B. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet and vertical scale of not less than 1 inch equals 5 feet . Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

C. Field quality-control test reports.

1.6 DELIVERY, STORAGE, AND HANDLING

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

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

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

1.7 PROJECT CONDITIONS

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

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

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. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

2.3 PVC PIPE AND FITTINGS

A. PVC Sewer Pipe and Fittings, 15” and Smaller: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

B. PVC Sewer Pipe and Fittings, 18” and Larger: ASTM F 679, T-1 wall thickness, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

C. PVC Profile Gravity Sewer Pipe and Fittings: ASTM F 794 pipe, with bell-and-spigot ends; ASTM D 3034 fittings, with bell ends; and ASTM F 477, elastomeric seals.

2.4 MANHOLES

A. Designed Precast Concrete Manholes: ASTM C 913; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.

1. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
2. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
3. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
4. Steps: Individual FRP steps or FRP ladder wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.

5. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover. Include sealant recommended by ring manufacturer.
6. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
7. Protective Coating: Plant-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint 10-mil minimum thickness applied to exterior and interior surfaces.
8. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."

    a. Material: ASTM A 536, Grade 60-40-18 ductile iron, unless otherwise indicated.
    b. Protective Coating: Foundry-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 10-mil minimum thickness applied to all surfaces, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING APPLICATIONS

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

1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.

    a. Shielded flexible couplings for same or minor difference OD pipes.
    b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
    c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

2. Use pressure-type pipe couplings for force-main joints.

B. Gravity-Flow, Nonpressure Sewer Piping: Use the following pipe materials for each size range:
1. 3”: 4” PVC sewer pipe and fittings, gaskets, and gasketed joints.
2. 4” : PVC sewer pipe and fittings, gaskets, and gasketed joints.
3. 5” and 6”: 6” cellular-core PVC pipe, PVC sewer pipe fittings, and solvent-cemented joints.
4. 5” and 6”: 6” PVC sewer pipe and fittings, gaskets, and gasketed joints.

3.3 PIPING INSTALLATION

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

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

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

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

E. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or combination of both.

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

1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
2. Install 6” and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
3. Install piping below frost line.
4. Install PVC profile gravity sewer piping according to ASTM D 2321 and ASTM F 1668.

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

3.4 PIPE JOINT CONSTRUCTION

A. Basic piping joint construction is specified in Division 22 Section "Common Work Results for Plumbing" Where specific joint construction is not indicated, follow piping manufacturer's written instructions.

B. Join gravity-flow, nonpressure, drainage piping according to the following:
1. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
2. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.

3.5 MANHOLE INSTALLATION

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

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Install FRP manholes according to manufacturer's written instructions.

D. Form continuous concrete channels and benches between inlets and outlet.

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

F. Install manhole cover inserts in frame and immediately below cover.

3.6 CONCRETE PLACEMENT

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

3.7 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22 Section "Sanitary Waste and Vent Piping."

B. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
2. Make branch connections from side into existing piping, 4” to 20”. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi .
3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall, unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

    a. Use concrete that will attain minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.
    b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

C. Connect to grease interceptors specified in Division 22 Section "Sanitary Waste Interceptors."

3.8 CLOSING ABANDONED SANITARY SEWERAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8-inch- thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Backfill to grade according to Division 31 Section "Earth Moving."

3.9 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.10 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:

    a. Allowable leakage is maximum of 50 gal./inch of nominal pipe size per mile of pipe, during 24-hour period.
    b. Close openings in system and fill with water.
    c. Purge air and refill with water.
    d. Disconnect water supply.
    e. Test and inspect joints for leaks.
    f. Option: Test ductile-iron piping according to AWWA C600, "Hydrostatic Testing" Section. Use test pressure of at least 10 psig.

6. Manholes: Perform hydraulic test according to ASTM C 969.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.11 CLEANING

A. Clean interior of piping of dirt and superfluous material.

END OF SECTION 221313

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pipe and pipe fittings.
2. Sanitary waste and vent piping system.

B. RELATED SECTIONS
1. Section 230529 – Hangers and Supports.
2. Section 230548 – Mechanical Sound, Vibration and Seismic Control.
3. Section 230700 - Piping Insulation.
4. Section 224000 - Plumbing Fixtures.
5. Section 224010 - Plumbing Specialties.
6. Division 31 – Excavating, Earthwork, Trenching.
7. Division 8 - Access Doors.
8. Division 9 - Painting.

1.2 REFERENCES

A. Division 1 - Quality Control

B. ASME B16.3 - Malleable Iron Threaded Fittings.

C. ASME B16.4 - Cast Iron Threaded Fittings Class 125 and 250.

D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.

E. ASME B16.22 - Wrought Copper and Bronze Solder Joint Pressure Fittings.

F. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.

G. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.

H. ASME B31.9 - Building Service Piping.

I. ASTM A74 - Cast Iron Soil Pipe and Fittings.

J. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

K. ASTM E814 - Fire Tests of Through-Penetration Fire Stops.

L. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems.

M. CISPI 310 - Joints for Hubless Cast Iron Sanitary Systems.

N. UL 1479 - Fire Tests of Through-Penetration Firestops.

1.3 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 1.

B. Maintenance Data: Include installation instructions, spare parts lists.

1.5 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Welding Materials and Procedures: Conform to ASME Code and applicable state regulations.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 5 years experience.

B. Installer: Company specializing in performing the work of this section with minimum 3 years experience.

1.7 REGULATORY REQUIREMENTS

A. Perform Work in accordance with the latest edition of the, BOCA, NFPA and all local codes.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 1.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.1 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. PVC Pipe: NSF-DWV, Schedule 40.
   1. Fittings: PVC.
   2. Joints: Solvent welded.

2.2 SANITARY SEWER PIPING, ABOVE GRADE

A. No-Hub Cast Iron Pipe:
   1. Fittings: No-Hub Cast Iron.
   2. Joints: Neoprene gasket with stainless steel clamps.

2.3 VENT PIPING, ABOVE GRADE

A. No-Hub Cast Iron Pipe:
   1. Fittings: No-Hub Cast Iron.
   2. Joints: Neoprene gasket with stainless steel clamps.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify excavations under provisions of Division 1.

B. Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

D. Install piping to maintain headroom, conserve space, and not interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

G. Establish elevations of buried piping outside the building to ensure not less than 3 feet of cover for sanitary lines.

H. Install vent piping penetrating roofed areas to maintain integrity of roof assembly.

I. Excavate and backfill in accordance with Division 2.

J. Install bell and spigot pipe with bell end upstream.

3.4 ERECTION TOLERANCES

A. Establish invert elevations, slopes for drainage per code or as noted on the drawings.

3.5 SERVICE CONNECTIONS

A. Provide new sanitary sewer service. Coordinate service with the site engineer. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing. All piping buried under roadways shall be in conformance with local requirements.

B. All new services shall be coordinated with the local utility companies. Contractor shall pay permitting fees. Owner shall pay the tap and connection fees.

END OF SECTION 221316

SECTION 221413 - FACILITY STORM 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. This Section includes the following storm drainage piping inside the building:

1. Pipe, tube, and fittings.
2. Special pipe fittings.

B. Related Sections include the following:

1.3 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

1.4 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.

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. LEED Submittal:

1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.

C. Shop Drawings:
1. Controlled-Flow Storm Drainage System: Include calculations, plans, and details.

D. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

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

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. 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.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

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

B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.

a. Manufacturers:

1) ANACO.
2) Fernco, Inc.
3) Ideal Div.; Stant Corp.
4) Mission Rubber Co.
5) Tyler Pipe; Soil Pipe Div.

2.4 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Cellular-Core, Sewer and Drain Series, PVC Pipe: ASTM F 891, Series PS 100.

1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Series PS 100 sewer and drain pipe.

D. Solvent Cement and Adhesive Primer:

1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Aboveground storm drainage piping 6” and smaller shall be the following:

1. Cellular core PVC pipe, PVC socket fittings, and solvent-cemented joints.

B. Underground storm drainage piping 6” and smaller shall be the following:

1. Hubless cast-iron soil pipe and fittings; [standard,] [and] [heavy-duty] shielded, stainless-steel couplings; and coupled joints.

3.3 PIPING INSTALLATION

A. Storm sewer and drainage piping outside the building are specified in Division 33 Section "Storm Utility Drainage Piping."

B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

C. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Storm Drainage Piping Specialties."

D. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.

E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."

F. 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."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

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

H. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping

upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

I. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:

1. Building Storm Drain: 1 percent downward in direction of flow for piping 3” and smaller; 1 percent downward in direction of flow for piping 4” and larger.
2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

J. Install engineered controlled-flow storm drainage piping in locations indicated.

K. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

L. Install ABS storm drainage piping according to ASTM D 2661.

M. Install PVC storm drainage piping according to ASTM D 2665.

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

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

C. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:

    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.

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.

B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

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

D. Rod diameter may be reduced 1 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. 1-1/2” and 2”: 60 inches with 3/8-inch rod.
2. 3”: 60 inches with 1/2-inch rod.
3. 4” and 5”: 60 inches with 5/8-inch rod.
4. 6”: 60 inches with 3/4-inch rod.

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

G. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. 1-1/2” and 2”: 48 inches with 3/8-inch rod.
2. NPS 3”: 48 inches with 1/2-inch rod.
3. NPS 4” and 5”: 48 inches with 5/8-inch rod.
4. NPS 6”: 48 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 48 inches with 7/8-inch rod.

H. Install supports for vertical PVC piping every 48 inches.

I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 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.

3.7 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. 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 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. 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. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping, on completion of roughing-in. 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 to 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.

3.8 CLEANING

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.

END OF SECTION 221413

SECTION 221423 – STORM DRAINAGE 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. This Section includes the following storm drainage piping specialties:
   1. Cleanouts.
   2. Roof drains.
   3. Miscellaneous storm drainage piping specialties.
   4. Flashing materials.

B. Related Sections include the following:

   1. Division 22 Section "Sanitary Waste Piping Specialties" for backwater valves, floor drains, trench drains and channel drainage systems connected to sanitary sewer, air admittance valves, FOG disposal systems, grease interceptors and removal devices, oil interceptors, and solid interceptors.

1.3 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

1.6 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:

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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings:

    a. Josam Company; Josam Div.
    b. MIFAB, Inc.
    c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    d. Tyler Pipe; Wade Div.
    e. Watts Drainage Products Inc.
    f. Zurn Plumbing Products Group; Specification Drainage Operation.

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

B. Metal Floor Cleanouts:

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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

    a. Josam Company; Josam Div.
    b. Oatey.
    c. Sioux Chief Manufacturing Company, Inc.
    d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    e. Tyler Pipe; Wade Div.
    f. Watts Drainage Products Inc.
    g. Zurn Plumbing Products Group; Light Commercial Operation.
    h. Zurn Plumbing Products Group; Specification Drainage Operation.

4. Standard: ASME A112.36.2M for adjustable housing cleanout.
5. Size: Same as connected branch.
6. Type: Adjustable housing.
7. Body or Ferrule: Cast iron.
8. Clamping Device: Required.
9. Outlet Connection: Threaded.
10. Closure: Cast-iron plug.
11. Adjustable Housing Material: Cast iron.
12. Frame and Cover Material and Finish: Polished bronze.
13. Frame and Cover Shape: Round.
14. Top Loading Classification: Medium Duty.
15. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

    a. Josam Company; Josam Div.
    b. MIFAB, Inc.
    c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    d. Tyler Pipe; Wade Div.
    e. Watts Drainage Products Inc.
    f. Zurn Plumbing Products Group; Specification Drainage Operation.

4. Standard: ASME A112.36.2M. Include wall access.
5. Size: Same as connected drainage piping.
6. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
7. Closure: cast-iron plug.
8. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
9. Wall Access: Round, deep, chrome-plated bronze cover plate with screw.
10. Wall Access: Round wall-installation frame and cover.

D. Plastic Floor Cleanouts:

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

    a. Canplas LLC.
    b. IPS Corporation.
    c. NDS Inc.
    d. Plastic Oddities; a division of Diverse Corporate Technologies.
    e. Sioux Chief Manufacturing Company, Inc.
    f. Zurn Plumbing Products Group; Light Commercial Operation.

3. Size: Same as connected branch.
4. Body: PVC.
5. Closure Plug: PVC.
6. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.2 ROOF DRAINS

A. Metal Roof Drains (RD):

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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
    a. Josam Company; Josam Div.
    b. Marathon Roofing Products.

c. MIFAB, Inc.
d. Portals Plus, Inc.
e. Prier Products, Inc.
f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
g. Tyler Pipe; Wade Div.
h. Watts Drainage Products Inc.
i. Zurn Plumbing Products Group; Light Commercial Operation.
j. Zurn Plumbing Products Group; Specification Drainage Operation.

4. Standard: ASME A112.21.2M.
5. Pattern: Roof drain.
6. Body Material: Cast iron.
7. Combination Flashing Ring and Gravel Stop: Not required.
8. Flow-Control Weirs: Not required.
9. Outlet: Side.
10. Dome Material: Cast iron.
11. Extension Collars: Required.
12. Underdeck Clamp: Required.
13. Sump Receiver: Not required.

2.3 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft. thickness.

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

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

1. Size same as drainage piping up to 4”. Use 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 4” and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

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

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

F. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07.

1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Position roof drains for easy access and maintenance.

G. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

H. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

I. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

B. Set flashing on floors and roofs in solid coating of bituminous cement.

C. Secure flashing into sleeve and specialty clamping ring or device.

D. Fabricate and install flashing and pans, sumps, and other drainage shapes.

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 221413

SECTION 221429 - SUMP PUMPS

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. Submersible sump pumps.
2. Wet-pit-volute sump pumps.
3. Sump-pump basins and basin covers.
4. Packaged drainage-pump units.

B. Related Section:

1. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. [Include construction details, material descriptions, dimensions of individual components and profiles.] [Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.]

B. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls, to 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.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.1 SUBMERSIBLE SUMP PUMPS

A. Submersible, Fixed-Position, Single-Seal Sump Pumps:
1. Description: Factory-assembled and -tested sump-pump unit.
2. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
3. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
4. Pump and Motor Shaft: Stainless steel[or steel], with factory-sealed, grease-lubricated ball bearings.
5. Seal: Mechanical.
6. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: [Air] [Oil].

7. Controls:

    a. Enclosure: NEMA 250,
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

8. Controls:

    a. Enclosure: NEMA 250,
    b. Switch Type: Mechanical-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

9. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.

B. Submersible, Fixed-Position, Double-Seal Sump Pumps:
1. Description: Factory-assembled and -tested sump-pump unit.

2. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
3. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
4. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
5. Seals: Mechanical.
6. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
7. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

8. Controls:

    a. Enclosure: NEMA 250,
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

9. Controls:

    a. Enclosure: NEMA 250,.
    b. Switch Type: Mechanical-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

10. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.

2.2 SUMP-PUMP BASINS AND BASIN COVERS

A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.

1. Material: Polyethylene
2. Reinforcement: Mounting plates for pumps, fittings, and accessories.
3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.

B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.

1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

2.3 PACKAGED DRAINAGE-PUMP UNITS

A. Packaged Pedestal Drainage-Pump Units:
   1. Description: Factory-assembled and -tested, automatic-operation, freestanding, sump-pump unit.
   2. Pump Type: Wet-pit-volute, single-stage, separately-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
   3. Pump Casing: Corrosion-resistant material, with strainer inlet, design that permits flow into impeller, and vertical discharge for piping connection.
   4. Impeller: Aluminum, brass, or plastic.
   5. Motor: With built-in overload protection and mounted vertically on sump pump column.
   6. Power Cord: Three-conductor, waterproof cable of length required but not less than 72 inches with grounding plug and cable-sealing assembly for connection at pump.
   7. Control: Float switch.

2.4 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing 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. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation and filling are specified in Section 312000 "Earth Moving."

3.2 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.3 INSTALLATION

A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

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

3.5 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. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Pumps and controls will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain[controls and] pumps.

END OF SECTION 221429

SECTION 223400 - DOMESTIC WATER HEATERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Domestic Hot Water Heaters.

B. RELATED SECTIONS
   1. Section 230548 – Mechanical Sound, Vibration, and Seismic Control.
   2. Section 262800 – Wiring Connections

1.2 REFERENCES

A. ASHRAE 90A - Energy Conservation in New Building Design.

B. Pennsylvania Code, Title 34, Labor and Industry, Chapter 3, Boilers and Unfired Pressure Vessels.

C. NFPA 54 - National Fuel Gas Code.

D. NFPA 70 - National Electrical Code.

1.3 SUBMITTALS FOR REVIEW

A. Division 1 - Submittals: Procedures for submittals.

B. Product Data:
   1. Provide electrical characteristics and connection requirements.

C. Manufacturer's Installation Instructions

1.4 SUBMITTALS AT PROJECT CLOSEOUT

A. Division 1 - Contract Closeout: Operation and Maintenance Data, Warranties: Procedures for submittals.

B. Project Record Documents: Record actual locations of components and equipment.

C. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

D. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Ensure products and installation of specified products are in conformance with recommendations and requirements of the following organizations:
   1. American Gas Association (AGA).
   2. National Sanitation Foundation (NSF).
   3. American Society of Mechanical Engineers (ASME).
   4. National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).
   5. National Electrical Manufacturers' Association (NEMA).
   6. Underwriters Laboratories (UL).
   7. Latest edition of BOCA and all local codes.

C. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.6 DELIVERY, STORAGE, AND PROTECTION

A. Division 1 - Material and Equipment: Transport, handle, store, and protect products.

B. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.7 WARRANTY

A. Division 1 - Contract Closeout, Warranties.

B. Provide five year manufacturer warranty for domestic water heaters and packaged water heating systems.

1.8 MAINTENANCE PRODUCTS

A. Division 1 - Contract Closeout, Operation and Maintenance Data.

1.9 EXTRA MATERIALS

A. Division 1 - Contract Closeout, Operation and Maintenance Data.

PART 2 PRODUCTS

2.1 COMMERCIAL ELECTRIC DOMESTIC HOT WATER HEATERS

A. Manufacturer: A.O. Smith

B. Other acceptable manufacturers offering equivalent.
   1. State

C. System: Electric water heaters, controls, piping and valving as indicated.

D. Heater:
   1. U.L. Listed.
   2. Heater Element – Element shall be a durable, stainless steel element.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install domestic hot water heaters in accordance with manufacturer's instructions and to AGA NSF NFPA 54 UL requirements.

B. Coordinate electrical work to achieve operating system.

C. Domestic Hot Water Heaters:
1. Clean and flush after installation. Seal until pipe connections are made.

END OF SECTION 223400

SECTION 224000 - PLUMBING FIXTURES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Water closets.
2. ADA water closets.
3. Lavatories.
4. Showers.

B. RELATED SECTIONS
1. Division 12 – Manufacturered Laminate Factory Casework.
2. Division 7 - Joint Sealers: Seal fixtures to walls and floors.
3. Section 230529 – Hangers and Supports.
4. Section 221116 – Domestic Water Piping.
5. Section 221316 – Sanitary Waste and Vent Piping.
6. Section 224010 - Plumbing Specialties.
7. Section 262800 - Wiring Connections.
8. Division 10 - Toilet and Bath Accessories: Product requirements for integral lavatory counter tops for placement by this Section.

1.2 REFERENCES

A. ASME A112.6.1 - Supports for Off-the-Floor Plumbing Fixtures for Public Use.

B. ASME A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.

C. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.

1.3 SUBMITTALS FOR REVIEW

A. Division 1 - Submittals: Procedures for submittals.

B. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

1.4 SUBMITTALS FOR INFORMATION

A. Division 1 - Submittals: Procedures for submittals.

B. Manufacturer's Instructions: Indicate installation methods and procedures.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

A. Division 1 - Contract Closeout: Operation and Maintenance Data, Warranties: Procedures for submittals.

B. Maintenance Data: Include fixture trim exploded view and replacement parts lists.

C. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.7 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc.

1.8 DELIVERY, STORAGE, AND PROTECTION

A. Division 1 - Material and Equipment: Transport, handle, store, and protect products.

B. Accept fixtures on site in factory packaging. Inspect for damage.

C. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.9 WARRANTY

A. Division 1 - Contract Closeout, Warranties.

1.10 EXTRA MATERIALS

A. Division 1 - Contract Closeout, Operation and Maintenance Data.

PART 2 PRODUCTS

2.1 WATER CLOSETS

A. Acceptable Manufacturers:
   1. American Standard.
   2. Kohler.
   3. Eljer.

B. Provide all appurtenances for a complete installation including wall carriers.

C. Provide battery operated automatic faucets.

D. Fixtures noted on the architectural plans as handicapped shall meet the requirements of ADA.

2.2 LAVATORIES

A. Acceptable Manufacturers
   1. American Standard.
   2. Kohler.
   3. Eljer.

B. Provide lavatories as noted on the Architectural Drawings. Provide all appurtenances for a complete installation including semi-cast p-trap, chrome plated stops, wall carriers and chrome plated supply fittings.

C. Provide battery operated faucets.

D. Accessories:
   1. Chrome plated semi-cast brass 17-gauge P-trap with clean-out plug and arm with escutcheon.
   2. Wheel handle stops (in public bathrooms provide keyed stops).
   3. Rigid supplies.
   4. Safety Covers conforming to ANSI A177.1 and consisting of insulation kit of molded closed cell vinyl construction, 3/16 inch thick, white color, for insulating tailpiece, P-trap, valves, and supply piping. Furnish with weep hole and angle valve access covers.

E. Fixtures noted on the architectural plans as handicapped shall meet the requirements of ADA.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 1 - Coordination and Meetings: Verification of existing conditions before starting work.

B. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

C. Verify that electric power is available and of the correct characteristics.

D. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

3.2 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning.

B. Provide chrome plated rigid supplies to fixtures with stops, reducers, and escutcheons.

C. Install components level and plumb.

D. Install and secure fixtures in place with wall carriers and bolts.

E. Seal fixtures to wall and floor surfaces with sealant as specified in Division 7, color to match fixture.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.5 ADJUSTING

A. Division 1 - Contract Closeout, Starting of Systems: Adjusting installed work.

B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING

A. Division 1 - Contract Closeout: Cleaning installed work.

B. Clean plumbing fixtures and equipment.

3.7 PROTECTION OF FINISHED WORK

A. Division 1 - Contract Closeout: Protecting installed work.

B. Do not permit use of fixtures.

3.8 SCHEDULES

A. Refer to drawings for complete plumbing fixture schedule.

B. All fixture heights, types, and locations shall be coordinated with the Architect.

C. Fixture Rough-In - Refer to fixture manufacturer’s rough-in guide.

END OF SECTION 224000

SECTION 224010 - PLUMBING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Floor drains.
2. Cleanouts.
3. Hose bibbs.
4. Backflow preventers.
5. Water hammer arrestors.
6. Thermostatic mixing valve.

B. RELATED SECTIONS
1. Section 221116 – Domestic Water Piping.
2. Section 221316 – Sanitary, Waste and Vent Piping.
3. Section 221413 – Storm Drainage Piping.
4. Section 224000 - Plumbing Fixtures.
5. Section 262800 - Wiring Connections: Electrical characteristics and wiring connections.

1.2 REFERENCES

A. ASME A112.21.1 - Floor Drains.

B. ASME A112.26.1 - Water Hammer Arrestors.

C. ASSE 1011 - Hose Connection Vacuum Breakers.

D. ASSE 1012 - Backflow Preventers with Immediate Atmospheric Vent.

E. ASSE 1013 - Backflow Preventers, Reduced Pressure Principle.

F. AWWA C506 - Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.

G. PDI WH-201 - Water Hammer Arrestors.

1.3 SUBMITTALS FOR REVIEW

A. Division 1 - Submittals: Procedures for submittals.

B. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.

C. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.

1.4 SUBMITTALS FOR INFORMATION

A. Division 1 - Submittals: Procedures for submittals.

B. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

A. Division 1 - Contract Closeout, Operation and Maintenance Data, Warranties and Bonds: Procedures for submittals.

B. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, water hammer arrestors, valves.

C. Operation Data: Indicate frequency of treatment required for interceptors.

D. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Division 1 - Material and Equipment: Transport, handle, store, and protect products.

B. Accept specialties on site in original factory packaging. Inspect for damage.

1.8 MAINTENANCE PRODUCTS

A. Division 1 - Contract Closeout, Operation and Maintenance Data.

PART 2 PRODUCTS

2.1 FLOOR DRAINS

A. Floor Drains:
   1. Manufacturers:
      a. Josam.
      b. Zurn.
      c. Wade.
      d. Smith.

2.2 CLEANOUTS

A. Cleanouts:
   1. Manufacturers:
      a. Josam.
      b. Zurn.
      c. Wade.
      d. Smith.

2.3 HOSE BIBBS

A. Hose Bibbs:
   1. Manufacturers:
      a. Josam.
      b. Zurn.
      c. Wade.
      d. Smith.

2. Bronze or brass non-freeze type with integral mounting flange, replaceable hexagonal disc, hose thread spout, chrome plated where exposed with handwheel, integral vacuum breaker in conformance with ANSI/ASSE 1011.

2.4 BACKFLOW PREVENTERS

A. Reduced Pressure Backflow Preventers:
   1. Manufacturers:
      a. Watts.
      b. Zurn.
      c. Josam.
      d. Substitutions: Not permitted.
   2. AWWA C511; Epoxy coated cast iron body with bronze internal parts and stainless steel trim; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.

B. Double Check Valve Assemblies:
   1. Manufacturers:
      a. Watts.
      b. Zurn.
      c. Josam.
      d. Substitutions: Not permitted.
   2. AWWA C510-89 epoxy coated cast iron body with bronze resistant internal parts and stainless steel trim; two independently operating check valves with intermediate atmospheric vent.

2.5 THERMOSTATIC MIXING VALVES

A. Manufacturer: Symmons.

B. Other acceptable manufacturers offering equivalent products.
   1. Lawler.

C. Valve: Chrome plated cast brass body, stainless steel or copper alloy bellows, integral temperature adjustment.

D. Accessories:
   1. Check valve on inlets.
   2. Volume control shut-off valve on outlet.
   3. Stem thermometer on outlet.
   4. Strainer stop checks on inlets.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

C. Encase exterior cleanouts in reinforced concrete flush with grade.

D. Install floor cleanouts at elevation to accommodate finished floor.

E. Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.

F. Pipe relief from backflow preventer to nearest drain.

END OF SECTION 224010

SECTION 224713 - DRINKING FOUNTAINS

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 drinking fountains and related components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of drinking fountain.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include operating characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For drinking fountains to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 DRINKING FOUNTAINS

A. Drinking Fountains Antifreeze, pedestal.
1. Standard: Comply with NSF 61 Annex G.
2. Designed to operate without draining into ground.
3. Pedestal: Rectangular, painted cast iron or steel.
4. Receptor: Rectangular, chrome-plated brass or stainless steel with bubbler.
5. Maximum water flow: .5 gpm.
6. Control: Foot pedal with control valve assembly.
7. Supply Fittings: Underground shutoff and flow-control valve assembly.
8. Drain: Grid type with 1-1/2” minimum waste.
9. Bury Depth, Grade to Valve Components: 36”
10. Supply Piping: 1/2"
11. Waste Piping: 1-1/2” minimum trap and waste.

B. Drinking Fountains: Stainless steel, wall mounted.

1. Bronze Drinking Fountains:

2. Stainless-Steel Drinking Fountains:

3. Vitreous-China Drinking Fountains:

4. Standards:

   a. Comply with ASME A112.19.2/CSA B45.1.
   b. Comply with NSF 61 Annex G.

5. Maximum water flow: 0.5 gpm.
6. Control: Push button
7. Drain: Grid type with 1-1/4” tailpiece.
8. Supply: 3/8” with shutoff valve.
9. Waste Fitting: ASME A112.18.2/CSA B125.2, 1-1/4 chrome-plated brass P-trap and waste.
10. Support: Type I water cooler carrier
11. Drinking Fountain Mounting Height: Standard and Handicapped/elderly according to ICC A117.1.

2.2 SUPPORTS

A. Type I Water Cooler Carrier:
   1. Standard: ASME A112.6.1M.

B. Type II Water Cooler Carrier:
   1. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.

B. Set pedestal drinking fountains on floor.

C. Install recessed drinking fountains secured to wood blocking in wall construction.

D. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

E. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."

F. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

G. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

H. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Install ball or gate shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."

D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

3.5 CLEANING

A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

C. Provide protective covering for installed fixtures.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224713

SECTION 230500 - COMMON WORK RESULTS 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. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Equipment installation requirements common to equipment sections.
9. Painting and finishing.
10. Concrete bases.
11. Supports and anchorages.

1.3 DEFINITIONS

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

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

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

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

G. 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.

4. Escutcheons.

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 HVAC 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.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

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

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

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. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 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 23 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. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

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

H. Solvent Cements for Joining Plastic Piping:

1. CPVC Piping: ASTM F 493.

2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

A. 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. 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.

C. 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.

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.

c. Eclipse, Inc.

d. Epco Sales, Inc.

e. Hart Industries, International, Inc.

f. Watts Industries, Inc.; Water Products Div.

g. 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.

d. Watts Industries, Inc.; Water Products Div.

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 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Available Manufacturers:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Metraflex Co.

d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Plastic. Include two for each sealing element.

4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends and a welded steel water stop, unless otherwise indicated.

B. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

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

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

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

3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 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 free of sags and bends.

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

J. Install piping to allow application of insulation.

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

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. 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 with spring clips.
    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, stamped-steel type with set screw.
    h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
2. Existing Piping: Use the following:
    a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
    b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
    c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
    d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
    e. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated finish.
    f. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
    g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.
    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

   a. Steel Pipe Sleeves: For pipes smaller than NPS 6.

   b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.

   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

      1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using 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.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.

2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

T. Verify final equipment locations for roughing-in.

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

3.2 PIPING 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. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. 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.

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

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

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
4. PVC Nonpressure Piping: Join according to ASTM D 2855.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

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

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.3 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.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 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 HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

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

3.5 PAINTING

A. Painting of HVAC systems, equipment, 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.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of 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. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.7 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 HVAC materials and equipment.

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

3.8 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 230500

SECTION 230529 - HANGERS AND SUPPORTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Flashing.
5. Sleeves.
6. Mechanical sleeve seals.
7. Firestopping relating to mechanical work.
8. Firestopping accessories.
9. Equipment bases and supports.

B. Related Sections:
1. Section 230548 - Mechanical Sound, Vibration, and Seismic Control: Product and execution requirements for vibration isolators.
2. Section 232113 - Heating and Cooling Piping: Execution requirements for placement of hangers and supports specified by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B31.9 - Building Services Piping.

B. American Society for Testing and Materials:
1. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

C. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.

D. Factory Mutual System:
1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

F. Underwriters Laboratories Inc.:
1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
3. UL 1479 - Fire Tests of Through-Penetration Firestops.
4. UL - Fire Resistance Directory.

G. Warnock Hersey:
1. WH - Certification Listings.

1.3 DEFINITIONS

A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.4 SYSTEM DESCRIPTION

A. Firestopping Materials: ASTM E119, ASTM E814, UL 263, UL 1479, to achieve fire ratings of adjacent construction.

B. Surface Burning: ASTM E84, UL 723 with maximum flame spread / smoke developed rating of 25/450.

C. Firestop interruptions to fire rated assemblies, materials, and components.

1.5 PERFORMANCE REQUIREMENTS

A. Firestopping: Conform to applicable code for fire resistance ratings and surface burning characteristics.

1.6 SUBMITTALS

A. Division 1 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.

C. Product Data:
1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
2. Firestopping: Submit data on product characteristics, performance and limitation criteria.

D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Manufacturer's Installation Instructions:
1. Hangers and Supports: Submit special procedures and assembly of components.
2. Firestopping: Submit preparation and installation instructions.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with all local codes and standards.

B. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Division 1 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Division 1 - Product Requirements: Environmental conditions affecting products on site.

B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.

C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

D. Provide ventilation in areas to receive solvent cured materials.

1.11 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.12 WARRANTY

A. Division 1 - Execution Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for pipe hangers and supports.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:
   1. B-Line.
   2. Grinnell.
   3. Substitutions: Division 1 - Product Requirements.

B. Furnish materials in accordance with all applicable codes and standards.

C. Plumbing Piping - DWV:
   1. Conform to ASME B31.9; ASTM F708.
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.

3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
6. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Copper-plated, carbon-steel adjustable, ring.

D. Plumbing Piping - Water:
1. Conform to ASME B31.9; ASTM F708.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 inches and Larger: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
9. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 inches and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 4 inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Copper-plated, Carbon-steel ring.

E. Hydronic Piping:
1. Conform to ASME B31.9; ASTM F708.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 inches and Larger: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hooks.
9. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.

10. Wall Support for Hot Pipe Sizes 6 inches and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 4 Inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Copper-plated, carbon steel ring.

F. Copper Pipe Support: Copper-plated carbon-steel ring.

2.2 ACCESSORIES

A. Hanger Rods: Steel threaded both ends, threaded on one end, or continuous threaded.

2.3 INSERTS

A. Manufacturers:
1. Grinnell.
2. B-line.
3. Substitutions: Division 1 - Product Requirements.

B. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

A. Refer to roofing specifications.

2.5 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

2.6 FIRESTOPPING

A. Manufacturers:
1. Dow Corning Corp.
2. 3M fire Protection Products.
3. Substitutions: Division 1 - Product Requirements.

B. Furnish materials in accordance with all local codes and standards.

C. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
1. Silicone Firestopping Elastomeric Firestopping: Single component silicone elastomeric compound and compatible silicone sealant.

2. Foam Firestopping Compounds: Single component foam compound.
3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
4. Fiber Stuffing and Sealant Firestopping: Composite of mineral fiber stuffing insulation with silicone elastomer for smoke stopping.
5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
7. Firestop Pillows: Formed mineral fiber pillows.

2.7 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Dam Material: Permanent:
1. Mineral fiberboard.
2. Mineral fiber matting.

C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

D. General:
1. Furnish UL listed products.
2. Select products with rating not less than rating of wall or floor being penetrated.

E. Non-Rated Surfaces:
1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve, link-seal or approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 1 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify openings are ready to receive sleeves.

C. Verify openings are ready to receive firestopping.

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Obtain permission from Engineer before using powder-actuated anchors.

D. Do not drill or cut structural members.

E. Obtain permission from Engineer before drilling or cutting structural members.

3.3 INSTALLATION - INSERTS

A. Install inserts for placement in concrete forms.

B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.1; ASME B31.5; ASME 31.9; ASTM F708.

B. Support horizontal piping as scheduled. If not scheduled, support in accordance with the International Mechanical Code.

C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Use hangers with 1-1/2 inch minimum vertical adjustment.

F. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

G. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

H. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.

I. Support riser piping independently of connected horizontal piping.

J. Provide copper plated hangers and supports for copper piping.

K. Design hangers for pipe movement without disengagement of supported pipe.

L. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

M. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 230700.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 4” thick and extending 6 inches beyond supported equipment.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Provide rigid anchors for pipes after vibration isolation components are installed. Refer to Section 230548.

3.6 INSTALLATION – FLASHING

A. All roof work shall be performed in strict accordance with the roofing contractor's requirements. On new or warranted work MC shall pay the roofing contractor to perform all of his roof work.

B. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

C. Flash vent and soil pipes projecting 12 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal.

D. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.

E. Seal floor drains watertight to adjacent materials.

F. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms for sound control.

G. Provide curbs for mechanical roof installations 14 inches minimum high above roofing surface. Flash and counter-flash with sheet metal; seal watertight. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.

H. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.7 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with mechanical sleeve seals.

B. Set sleeves in position in forms. Provide reinforcing around sleeves.

C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.

E. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

F. Install stainless steel escutcheons at finished surfaces.

3.8 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items, requiring firestopping.

B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating.

D. Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.

E. Place intumescent coating in sufficient coats to achieve rating required.

F. Fire Rated Surface:
   1. Seal opening at floor, wall, partition, ceiling, and roof as follows:
      a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
      b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
      c. Pack void with backing material.
      d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
   2. Where conduit, and penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.

G. Non-Rated Surfaces:
   1. Seal opening through non-fire rated wall, partition, floor, ceiling, and roof opening as follows:
      a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
      b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
      c. Install type of firestopping material recommended by manufacturer.
   2. Install escutcheons where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
   3. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.

3.9 FIELD QUALITY CONTROL

A. Division 1 - Quality Requirements, 014000 - Execution Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.10 CLEANING

A. Division 1 - Execution Requirements: Requirements for cleaning.

B. Clean adjacent surfaces of firestopping materials.

3.11 PROTECTION OF FINISHED WORK

A. Division 1 - Execution Requirements: Requirements for protecting finished Work.

B. Protect adjacent surfaces from damage by material installation.

3.12 SCHEDULES

PIPE HANGER SPACING – Steel, Cast Iron or Copper Unless Noted.

PIPE SIZE (Inches)	MAX. HANGER SPACING (Feet)	HANGER ROD DIAMETER (Inches)
1/2	8	3/8
3/4	8	3/8
1	8	3/8
1-1/4	8	3/8
1-1/2	10	3/8
2	10	3/8
2-1/2	12	1/2
3	12	1/2
4	12	5/8
5	12	5/8
6	12	3/4
8	12	3/4
10	12	7/8
12	12	7/8
Spigot or No-Hub And at Joints	5	5/8

END OF SECTION 230529

SECTION 230548 - MECHANICAL SOUND, VIBRATION, AND SEISMIC CONTROL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Vibration isolation.

B. PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION
   1. Division 3 - Concrete: Placement of isolators in floating floor slabs.

C. PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION
   1. Division 3 - Concrete: Supply of concrete for placement by this Section.

D. RELATED SECTIONS
   1. Division 3 - Cast-in-Place Concrete.
   2. Section 230529 – Hangers and Supports.
   3. Section 230543 - Piping Expansion Compensation.
   4. Section 262800 - Wiring Connections

1.2 PERFORMANCE REQUIREMENTS

A. Provide vibration isolation on motor driven equipment over 0.5 HP, plus connected piping and ductwork.

B. Provide minimum static deflection of isolators for equipment as indicated.
   1. Under 400 rpm: 4 inch
   2. 400 - 600 rpm: 3.0 inch
   3. 600 - 800 rpm: 2 inch
   4. 800 - 900 rpm: 1 inch
   5. 1100 - 1500 rpm: 0.5 inch
   6. Over 1500 rpm: 0.5 inch

C. Use concrete inertia bases for fans having static pressure in excess of 3.5 inch WC or for base mounted motors in excess of 10 HP, and on base mounted pumps 7.5 HP or over.

1.3 SUBMITTALS

A. Submit under provisions of Division 1.

B. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each.

C. Product Data: Provide schedule of vibration isolator type with location and load on each.

D. Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.

E. Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to meet or exceed specified requirements.

1.4 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Peabody Noise Control.

B. Substitutions: Division 1 - Product Requirements.

2.2 VIBRATION ISOLATORS

A. Open Spring Isolators:
   1. Spring Isolators:
      a. For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
      b. Code: Color code springs for load carrying capacity.
   2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
   3. Spring Mounts: Provide with levelling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
   4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.

B. Restrained Spring Isolators:
   1. Spring Isolators:
      a. For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
      b. Code: Color code springs for load carrying capacity.
   2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
   3. Spring Mounts: Provide with levelling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
   4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
   5. Restraint: Provide heavy mounting frame and limit stops.

C. Closed Spring Isolators:
   1. Spring Isolators:
      a. For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
      b. Code: Color code springs for load carrying capacity.
   2. Type : Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
   3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
   4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance.

D. Restrained Closed Spring Isolators:
   1. Spring Isolators:

a. For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
b. Code: Color code springs for load carrying capacity.

2. Type : Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance and limit stops.

E. Spring Hanger:

1. Spring Isolators:
   a. For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
   b. Code: Color code springs for load carrying capacity.
2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
4. Misalignment: Capable of 20 degree hanger rod misalignment.

F. Neoprene Pad Isolators:

1. Rubber or neoprene waffle pads.
   a. 30 durometer.
   b. Minimum 1/2 inch thick.
   c. Maximum loading 40 psi.
   d. Height of ribs shall not exceed 0.7 times width.
2. Configuration: Single layer.

G. Rubber Mount or Hanger: Molded rubber designed for 0.5 inches deflection with threaded insert.

H. Glass Fiber Pads: Neoprene jacketed pre-compressed molded glass fiber.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install isolation for motor driven equipment.

C. Install spring hangers without binding.

D. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

E. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

F. Provide pairs of horizontal limit springs on fans with more than 6.0 inch static pressure, and on hanger supported, horizontally mounted axial fans.

G. Support piping connections to isolated equipment resiliently as follows:
   1. Up to 4 Inch Diameter: First three points of support.
   2. 5 to 8 Inch Diameter: First four points of support.
   3. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.
   4. Connect wiring to isolated equipment with flexible hanging loop.

3.2 MANUFACTURER'S FIELD SERVICES

A. Examine systems under provisions of Division 1.

B. Inspect isolated equipment after installation and submit report. Include static deflections.

END OF SECTION 230548

SECTION 230553 - MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Nameplates.
   2. Tags.
   3. Stencils.
   4. Pipe markers.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
   1. ASME A13.1 - Scheme for the Identification of Piping Systems.

B. National Fire Protection Association:
   1. NFPA 99 - Standard for Health Care Facilities.

1.3 SUBMITTALS

A. Division 1 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit manufacturers catalog literature for each product required.

C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Samples: Submit tags, labels, pipe markers, and size used on project.

E. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Division 1 - Execution Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.5 QUALITY ASSURANCE

A. Conform to NFPA 99 requirements for labeling and identification of medical gas piping systems and accessories.

B. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

C. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years experience approved by manufacturer.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.8 EXTRA MATERIALS

A. Division 1 - Execution Requirements: Spare parts and maintenance products.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:
   1. Seton.
   2. Brady.
   3. Substitutions: Division 1 - Product Requirements.

B. Furnish materials in accordance with local codes and standards.

C. Product Description: Laminated three-layer plastic with engraved letters on light contrasting background color.

2.2 TAGS

A. Metal Tags:
   1. Manufacturers:
      a. Seton.
      b. Brady.
      c. Substitutions: Refer to Division 1 - Product Requirements.
   2. Brass with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.

B. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame.

2.3 STENCILS

A. Manufacturers:
   1. Seton.
   2. Brady.
   3. Substitutions: Division 1 - Product Requirements.

B. Furnish materials in accordance with all local codes and standards.

C. Stencils: With clean cut symbols and letters of following size:
   1. Up to 2 inches Outside Diameter of Insulation or Pipe: 1/2 inch high letters.
   2. 2-1/2 to 6 inches Outside Diameter of Insulation or Pipe: 1-inch high letters.
   3. Over 6 inches Outside Diameter of Insulation or Pipe: 1-3/4 inches high letters.
   4. Ductwork and Equipment: 1-3/4 incheshigh letters.

D. Stencil Paint: As specified in Division 9, semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

2.4 PIPE MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Plastic Pipe Markers:
   1. Manufacturers:
      a. Seton.
      b. Brady.
      c. Substitutions: Refer to Division 1 - Product Requirements.
   2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

C. Plastic Tape Pipe Markers:
   1. Manufacturers:
      a. Seton.
      b. Brady.
      c. Substitutions: Refer to Division 1 - Product Requirements.
   2. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

A. Install identifying devices after completion of coverings and painting.

B. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

C. Install tags using corrosion resistant chain. Number tags consecutively by location.

D. Identify make-up air units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Identify in-line pumps and other small devices with tags.

E. Identify control panels and major control components outside panels with plastic nameplates.

F. Identify valves in main and branch piping with tags.

G. Identify air terminal units and radiator valves with numbered tags.

H. Tag automatic controls, instruments, and relays. Key to control schematic.

I. Identify piping, concealed or exposed, with plastic pipe markers or plastic tape pipe markers. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

J. Identify ductwork with plastic nameplates. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

K. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Testing adjusting, and balancing of hydronic and air-systems.

B. Related Sections:
1. Section 230900 - Direct Digital Controls: Requirements for coordination between DDC system and testing, adjusting, and balancing work.

1.2 REFERENCES

A. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.

B. Natural Environmental Balancing Bureau:
1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.3 SUBMITTALS

A. Division 1 - Submittal Procedures: Submittal procedures.

B. Prior to commencing Work, submit proof of latest calibration date of each instrument.

C. Test Reports: Indicate data on forms containing information indicated in Schedules.

D. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

E. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and Copy of NEBB Certificate of Conformance Certification.

F. Submit draft copies of report for review prior to final acceptance of Project.

G. Furnish reports in soft cover, letter size, 3-ring binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

1.4 CLOSEOUT SUBMITTALS

A. Division 1 - Execution Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

C. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

B. Maintain one copy of each document on site.

C. Prior to commencing Work, calibrate each instrument to be used. [Upon completing Work, recalibrate each instrument to assure reliability.]

1.6 QUALIFICATIONS

A. Agency: **Independent third party** company specializing in testing, adjusting, and balancing of systems specified in this section with minimum three years experience and Certified by NEBB.

B. Perform Work under supervision of NEBB Certified Testing, Balancing and Adjusting Supervisor.

1.7 SEQUENCING

A. Division 1 - Summary: Work sequence.

B. Sequence balancing between completion of systems tested and Date of Substantial Completion.

1.8 SCHEDULING

A. Division 1 - Administrative Requirements: Coordination and project conditions.

PART 2 PRODUCTS
Not used.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 1 - Administrative Requirements: Coordination and project conditions.

B. Verify systems are complete and operable before commencing work. Verify the following:
1. Systems are started and operating in safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Hydronic systems are flushed, filled, and vented.

13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place or in normal position.
15. Service and balancing valves are open.

3.2 PREPARATION

A. Furnish instruments required for testing, adjusting, and balancing operations.

B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.3 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 10 percent of design.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.4 ADJUSTING

A. Division 1 - Execution Requirements: Testing, adjusting, and balancing.

B. Verify recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.

E. Report defects and deficiencies noted during performance of services, preventing system balance.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.

H. Check and adjust systems approximately six months after final acceptance and submit report.

3.5 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities [at site altitude].

B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.

D. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.

E. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

F. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

G. At modulating damper locations, take measurements and balance at extreme conditions. Balance variable volume systems at maximum airflow rate, full cooling, and at minimum airflow rate, full heating.

H. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain neutral static building pressure near building entries.

I. For variable air volume system powered units set volume controller to airflow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable-air-volume temperature control.

3.6 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing:
   1. VRF System
   2. Fan-coil Units
   3. Exhaust Fans
   4. Energy Recovery Units

B. Report Forms
   1. Title Page:
      a. Name of Testing, Adjusting, and Balancing Agency
      b. Address of Testing, Adjusting, and Balancing Agency
      c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
      d. Project name
      e. Project location
      f. Project Architect
      g. Project Engineer
      h. Project Contractor
      i. Project altitude
      j. Report date
   2. Summary Comments:
      a. Design versus final performance
      b. Notable characteristics of system
      c. Description of systems operation sequence
      d. Summary of outdoor and exhaust flows to indicate building pressurization
      e. Nomenclature used throughout report
      f. Test conditions
   3. Instrument List:
      a. Instrument
      b. Manufacturer
      c. Model number
      d. Serial number

e. Range
f. Calibration date

4. Electric Motors:
   a. Manufacturer
   b. Model/Frame
   c. HP/BHP and kW
   d. Phase, voltage, amperage; nameplate, actual, no load
   e. RPM
   f. Service factor
   g. Starter size, rating, heater elements
   h. Sheave Make/Size/Bore
5. V-Belt Drive:
   a. Identification/location
   b. Required driven RPM
   c. Driven sheave, diameter and RPM
   d. Belt, size and quantity
   e. Motor sheave diameter and RPM
   f. Center to center distance, maximum, minimum, and actual
6. Pump Data:
   a. Identification/number
   b. Manufacturer
   c. Size/model
   d. Impeller
   e. Service
   f. Design flow rate, pressure drop, BHP and kW
   g. Actual flow rate, pressure drop, BHP and kW
   h. Discharge pressure
   i. Suction pressure
   j. Total operating head pressure
   k. Shut off, discharge and suction pressures
   l. Shut off, total head pressure
7. Cooling Coil Data:
   a. Identification/number
   b. Location
   c. Service
   d. Manufacturer
   e. Air flow, design and actual
   f. Entering air DB temperature, design and actual
   g. Entering air WB temperature, design and actual
   h. Leaving air DB temperature, design and actual
   i. Leaving air WB temperature, design and actual
   j. Water flow, design and actual
   k. Water pressure drop, design and actual
   l. Entering water temperature, design and actual
   m. Leaving water temperature, design and actual
   n. Saturated suction temperature, design and actual
   o. Air pressure drop, design and actual
8. Air Moving Equipment:
   a. Location
   b. Manufacturer
   c. Model number
   d. Serial number
   e. Arrangement/Class/Discharge
   f. Air flow, specified and actual
   g. Return air flow, specified and actual
   h. Outside air flow, specified and actual

i. Total static pressure (total external), specified and actual
j. Inlet pressure
k. Discharge pressure
l. Sheave Make/Size/Bore
m. Number of Belts/Make/Size
n. Fan RPM

9. Combustion Test:
   a. Manufacturer
   b. Model number
   c. Serial number
   d. Firing rate
   e. Overfire draft
   f. Gas meter timing dial size
   g. Gas meter time per revolution
   h. Gas pressure at meter outlet
   i. Gas flow rate
   j. Heat input
   k. Burner manifold gas pressure
   l. Percent carbon monoxide (CO)
   m. Percent carbon dioxide (CO2)
   n. Percent oxygen (O2)
   o. Percent excess air
   p. Flue gas temperature at outlet
   q. Ambient temperature
   r. Net stack temperature
   s. Percent stack loss
   t. Percent combustion efficiency
   u. Heat output
10. Return Air/Outside Air Data:
   a. Identification/location
   b. Design air flow
   c. Actual air flow
   d. Design return air flow
   e. Actual return air flow
   f. Design outside air flow
   g. Actual outside air flow
   h. Return air temperature
   i. Outside air temperature
   j. Required mixed air temperature
   k. Actual mixed air temperature
   l. Design outside/return air ratio
   m. Actual outside/return air ratio
   n. Exhaust Fan Data:
11. Exhaust Fan Data:
   a. Location
   b. Manufacturer
   c. Model number
   d. Serial number
   e. Air flow, specified and actual
   f. Total static pressure (total external), specified and actual
   g. Inlet pressure
   h. Discharge pressure
   i. Sheave Make/Size/Bore
   j. Number of Belts/Make/Size
   k. Fan RPM
12. Duct Traverse:

a. System zone/branch
b. Duct size
c. Area
d. Design velocity
e. Design air flow
f. Test velocity
g. Test air flow
h. Duct static pressure
i. Air temperature
j. Air correction factor

13. Duct Leak Test:

Duct leakage testing to be completed by PHIUS + Multi-family verifier.

a. Description of ductwork under test
b. Duct design operating pressure
c. Duct design test static pressure
d. Duct capacity, air flow
e. Maximum allowable leakage duct capacity times leak factor
f. Test apparatus
    1) Blower
    2) Orifice, tube size
    3) Orifice size
    4) Calibrated
g. Test static pressure
h. Test orifice differential pressure
i. Leakage

14. Terminal Unit Data:
a. Manufacturer
b. Type, constant, variable, single, dual duct
c. Identification/number
d. Location
e. Model number
f. Size
g. Minimum static pressure
h. Minimum design air flow
i. Maximum design air flow
j. Maximum actual air flow
k. Inlet static pressure

15. Air Distribution Test Sheet:
a. Air terminal number
b. Room number/location
c. Terminal type
d. Terminal size
e. Area factor
f. Design velocity
g. Design air flow
h. Test (final) velocity
i. Test (final) air flow
j. Percent of design air flow

END OF SECTION 230593

SECTION 230700 - MECHANICAL INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Piping insulation.
   2. Jackets and accessories.

1.2 REFERENCES

A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus.

C. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.

D. ASTM C240 - Standard Test Methods of Testing Cellular Glass Insulation Block.

E. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.

F. ASTM C518 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

G. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.

H. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

I. ASTM C547 - Standard Specification for Mineral Fiber Preformed Pipe Insulation.

J. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation.

K. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

L. ASTM D1784 - Standard Specification for Rigid PolyVinyl Chloride (PVC) Compounds and Chlorinated PolyVinyl Chloride (CPVC) Compounds.

M. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

N. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

O. NAIMA National Insulation Standards.

P. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

Q. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data: Provide product description, list of materials and thickness for each service, and locations.

C. Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.4 QUALITY ASSURANCE

A. Materials: Flame spread/smoke developed rating of 25/50 or less in accordance with UL 723.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Division 1.

B. Store insulation in original wrapping and protect from weather and construction traffic.

C. Protect insulation against dirt, water, chemical, and mechanical damage.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

PART 2 PRODUCTS

2.1 FIBERGLASS PIPE INSULATION

A. Manufacturers:
   1. Manville Micro-Lok
   2. Owens Corning
   3. Substitutions: Division 1 - Product Requirements.

B. Insulation: ASTM C547; Fiberglass pipe insulation
   1. 'K' value : ASTM C335, 0.23 at 75 degrees F.
   2. Maximum service temperature: 850 degrees F.
   3. Maximum moisture Absorbtion: less than 0.2% by volume.
   4. Maximum Flame Spread: ASTM E84; 25.
   5. Maximum Smoke Developed: ASTM E84; 50.

C. Jacketing
   1. Water vapor permeance: ASTM E96, 0.02 perm max.
   2. Tensile strength: ASTM D828, 30 lb.s/in. width min.

2.2 JACKETING

A. Manufacturers:
   1. Childers
   2. Pabco Metals Corp.
   3. Substitutions: Division 1 - Product Requirements.

B. Jacketing: ASTM B209, aluminum jacketing with factory applied polykraft moisture barrier.
   1. Polykraft: 40 lb. virgin kraft paper coated on one side with 1 mil polyethylene film.
   2. Prefabricated elbow covers with weather lock edge and epoxy moisture barrier.
   3. Thickness: 0.025 inch.
   4. Maximum Flame Spread: ASTM E84; 25.
   5. Maximum Smoke Developed: ASTM E84; 50.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. On exposed piping, locate insulation and cover seams in least visible locations.

C. Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory applied.
   2. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.

D. Rigid insulation inserts shall be installed for fiberglass insulation for pipe sizes 1-1/2” or larger under outside hangers. Galvanized metal shields shall be applied between the pipe insulation and hangers or supports, installed to manufacturer’s instructions.

E. Fiberglass pipe insulation shall be installed with factory precut insulation inserts for all fittings, installed according to manufacturer’s instructions. Inserts shall be of equal thickness to the adjoining pipe insulation and shall be provided with vapor retarder equal to adjoining pipe insulation.

F. Insulation shall be applied over clean, dry pipe with all joints butted firmly together, secured according to manufacturer’s instructions. Finish insulation at supports, protrusions, and interruptions.

G. Piping containment system shall be installed on any piping that runs above elevator equipment rooms, electrical, or telephone equipment areas.

3.3 PIPE INSULATION SCHEDULE

A. See schedule on drawings

END OF SECTION 230700

SECTION 230710 - DUCTWORK INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ductwork insulation.
   2. Duct liner.

B. RELATED SECTIONS
   1. Section 233113 - Ductwork.

1.2 REFERENCES

A. ASTM C518 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

B. ASTM E84 - Surface Burning Characteristics of Building Materials.

C. ASTM E96 - Water Vapor Transmission of Materials.

D. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

E. UL 723 - Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

A. According to the provisions of Division 1.

B. Product Data: Provide product description, list of materials and thickness for each service, and locations.

C. Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.4 QUALITY ASSURANCE

A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with UL 723.

1.5 QUALIFICATIONS

A. Applicator: Company specializing in performing the work of this section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in original factory packaging, labeled with manufacturer's density and thickness.

B. Store insulation in original wrapping and protect from weather and construction traffic.

C. Protect insulation against dirt, water, chemical, and mechanical damage.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

PART 2 PRODUCTS

2.1 GLASS FIBER DUCT LINER, RIGID

A. Manufacturers:
1. Owens Corning Aeroflex, type 200.
2. Equal by Cetainteed.
3. Equal by Knauf.

B. Insulation: ASTM C612; semi-rigid, noncombustible.
1. 'K' value : ASTM C518, 0.26 at 75 degrees F.
2. Maximum service temperature: 250 degrees F.
3. Maximum Velocity on Coated Air Side: 5,000 ft/min.
4. Density : 2.0 pounds/cubic foot.

2.2 GLASS FIBER DUCT WRAP

A. Manufacturers:
1. Owens Corning All Service Duct Wrap type 100.
2. Equal by Certainteed.
3. Equal by Manville.

B. Insulation: ASTM C553; faced, fiber glass blanket.
1. 'K' value : ASTM C518, 0.25 at 75 degrees F.
2. Maximum service temperature: 250 degrees F.
3. Water vapor permeance: 0.02 perms max.
4. Facing: ASTM C1136, factory laminated, reinforced foil/kraft.
5. Density : 1.0 pounds/cubic foot.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that ductwork has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Duct and Plenum Liner Application:
1. Adhere insulation with adhesive complying with ASTM 916 for 100 percent coverage.
2. Secure insulation with impact driven or weld secured mechanical liner fasteners. Refer to SMACNA Standards for spacing, but do not space with fewer fasteners than called for by manufacturer’s instructions.

3. Liner shall be cut to assure overlapped and compressed longitudinal corner joints. Transverse joints shall be neatly butted and there shall be no interruptions or gaps. Seal and smooth joints. Transverse duct joints and all exposed edges shall be coated.
4. Seal liner surface penetrations with adhesive.
5. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.
6. After installation, blow out duct system to remove foreign material remaining in duct. Coordinate with Owner and G.C. to protect interior building finishes and furnishings prior to blowing out duct.
7. Provide insulation with vapor barrier jackets.
8. Finish with tape and vapor barrier jackets.
9. Continue insulation through walls, sleeves, hangers, and other duct penetrations unless prohibited by code.
10. Insulate entire system including fittings, joints, flanges, flexible connections, and expansion joints.

C. Flexible Duct installation:
1. Install without crimping flexible duct. Install sheet metal duct where necessary to avoid crimping.
2. Flexible duct shall not be installed with turns in duct having centerline bending radius greater than 1 duct diameter.
3. Flexible duct shall be installed only at connections from sheet metal duct to diffusers.
4. Flexible duct shall not be installed in lengths greater than 6 feet.
5. Connect flexible duct to sheet metal duct by overlapping flexible duct over sheet metal, and use drawband plus fasteners for attaching.

D. Duct Wrap installation:
1. Before applying duct wrap, ducts shall be clean and dry. Completely follow all of manufacturer's installation recommendations.
2. Install duct wrap with facing outside. Insulation shall be tightly butted, with tape flaps overlapping insulation and facing, and installed so that insulation is not excessively compressed at duct corners. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners as required to prevent sagging.
3. Seal jacket joints with pressure sensitive tape, either foil or FRK backing stock, to provide a vapor tight system.
4. Where ducts are 24" in width or greater, duct wrap shall be additionally secured to duct with mechanical fasteners, spaced on 18" centers.
5. Stop and point insulation around access doors and damper operators to allow operation with distirbing wrapping.
6. For exterior applications, provide insulation with a vapor barrier jacket. Cover with outdoor jacket finish as specified with caulked aluminum jacket with seams located on bottom side of horizontal duct section. Waterproofing shall be ASTM E162 fire retardant type

3.3 TOLERANCE

A. Substituted insulation materials shall provide thermal resistance equal to or better than materials indicated, at normal conditions.

3.4 INSULATION SCHEDULE

A. See schedule on drawings.

END OF SECTION 230710

SECTION 230800 - COMMISSIONING OF HVAC

PART 1 GENERAL

1.01 SUMMARY

A. See Section 01 9113 - General Commissioning Requirements for overall objectives; comply with the requirements of Section 01 9113.

B. This section covers the Contractor's responsibilities for commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.

C. The Commissioning Authority (CA) directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor's use.

D. The entire HVAC system is to be commissioned, including commissioning activities for the following specific items:
   1. Control system.
   2. Major and minor equipment items.
   3. Piping systems and equipment.
   4. Ductwork and accessories.
   5. Terminal units.
   6. Sound control devices.
   7. Vibration control devices.
   8. Variable frequency drives.
   9. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.

1.02 RELATED REQUIREMENTS

A. Section 01 7900 - Demonstration and Training: Scope and procedures for Owner personnel training.

B. Section 01 9113 - Commissioning: Commissioning requirements that apply to all types of work.

C. Section 23 0923 - Direct-Digital Control System for HVAC.

D. Section 23 0913 - Instrumentation and Control Devices for HVAC.

E. Section 23 0993 - Sequence of Operations for HVAC Controls.

F. Section 23 0593 - Testing, Adjusting, and Balancing for HVAC.

1.03 REFERENCE STANDARDS

A. ASHRAE Guideline 1.1 - The HVAC Commissioning Process; 2012

1.04 SUBMITTALS

A. Updated Submittals: Keep the Commissioning Authority informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.

B. Prefunctional Checklists and Functional Test Procedures for Control System: Detailed written plan indicating the procedures to be followed to test, checkout and adjust the control system prior to full system Functional Testing; include at least the following for each type of equipment controlled:
   1. System name.
   2. List of devices.
   3. Step-by-step procedures for testing each controller after installation, including:
      a. Process of verifying proper hardware and wiring installation.
      b. Process of downloading programs to local controllers and verifying that they are addressed correctly.
      c. Process of performing operational checks of each controlled component.
      d. Plan and process for calibrating valve and damper actuators and all sensors.

e. Description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.

4. Copy of proposed log and field checkout sheets to be used to document the process; include space for initial and final read values during calibration of each point and space to specifically indicate when a sensor or controller has “passed” and is operating within the contract parameters.
5. Description of the instrumentation required for testing.
6. Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the Commissioning Authority and TAB contractor for this determination.

C. Startup Reports, Prefunctional Checklists, and Trend Logs: Submit for approval of Commissioning Authority.

D. HVAC Control System O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize at minimum the following data on the control system:
1. Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. Provide an index and clear table of contents. Include the detailed technical manual for programming and customizing control loops and algorithms.
2. Full as-built set of control drawings.
3. Full as-built sequence of operations for each piece of equipment.
4. Full points list; in addition to the information on the original points list submittal, include a listing of all rooms with the following information for each room:
   a. Floor.
   b. Room number.
   c. Room name.
   d. Air handler unit ID.
   e. Reference drawing number.
   f. Air terminal unit tag ID.
   g. Heating and/or cooling valve tag ID.
   h. Minimum air flow rate.
   i. Maximum air flow rate.
5. Full print out of all schedules and set points after testing and acceptance of the system.
6. Full as-built print out of software program.
7. Electronic copy on disk of the entire program for this facility.
8. Marking of all system sensors and thermostats on the as-built floor plan and HVAC drawings with their control system designations.
9. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
10. Control equipment component submittals, parts lists, etc.
11. Warranty requirements.
12. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).
13. Organize and subdivide the manual with permanently labeled tabs for each of the following data in the given order:
   a. Sequences of operation.
   b. Control drawings.
   c. Points lists.
   d. Controller and/or module data.
   e. Thermostats and timers.
   f. Sensors and DP switches.
   g. Valves and valve actuators.
   h. Dampers and damper actuators.
   i. Program setups (software program printouts).

E. Project Record Documents: See Section 01 7800 for additional requirements.
   1. Submit updated version of control system documentation, for inclusion with operation and maintenance data.
   2. Show actual locations of all static and differential pressure sensors (air, water and building pressure) and air-flow stations on project record drawings.

F. Draft Training Plan: In addition to requirements specified in Section 01 7900, include:
   1. Follow the recommendations of ASHRAE Guideline 1.
   2. Control system manufacturer's recommended training.
   3. Demonstration and instruction on function and overrides of any local packaged controls not controlled by the HVAC control system.

G. Training Manuals: See Section 01 7900 for additional requirements.
   1. Provide three extra copies of the controls training manuals in a separate manual from the O&M manuals.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

A. Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted such testing equipment will NOT become the property of Owner.

B. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.

PART 3 EXECUTION

3.01 PREPARATION

A. Cooperate with the Commissioning Authority in development of the Prefunctional Checklists and Functional Test Procedures.

B. Furnish additional information requested by the Commissioning Authority.

C. Prepare a preliminary schedule for HVAC pipe and duct system testing, flushing and cleaning, equipment start-up and testing, adjusting, and balancing start and completion for use by the Commissioning Authority; update the schedule as appropriate.

D. Notify the Commissioning Authority when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and testing, adjusting, and balancing will occur; when commissioning activities not yet performed or not yet scheduled will delay construction notify ahead of time and be proactive in seeing that the Commissioning Authority has the scheduling information needed to efficiently execute the commissioning process.

E. Put all HVAC equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.
   1. Include cost of sheaves and belts that may be required for testing, adjusting, and balancing.

F. Provide test holes in ducts and plenums where directed to allow air measurements and air balancing; close with an approved plug.

G. Provide temperature and pressure taps in accordance with the contract documents.
   1. Provide a pressure/temperature plug at each water sensor that is an input point to the control system.

3.02 INSPECTING AND TESTING - GENERAL

A. Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.

B. Perform the Functional Tests directed by the Commissioning Authority for each item of equipment or other assembly to be commissioned.

C. Provide two-way radios for use during the testing.

D. Valve/Damper Stroke Setup and Check:
   1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
   2. Set pump/fan to normal operating mode.
   3. Command valve/damper closed; visually verify that valve/damper is closed and adjust output zero signal as required.
   4. Command valve/damper open; verify position is full open and adjust output signal as required.
   5. Command valve/damper to a few intermediate positions.
   6. If actual valve/damper position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).
   7. Closure for Heating Coil Valves - Normally Open:
      a. Set heating setpoint 20 degrees F above room temperature.
      b. Observe valve open.
      c. Remove control air or power from the valve and verify that the valve stem and actuator position do not change.
      d. Restore to normal.
      e. Set heating setpoint to 20 degrees F below room temperature.
      f. Observe the valve close.
      g. Restore to normal.

E. Coil Valve Leak Check:
   1. Method 1 - Water Temperature With 2-Way Valve:
      a. Calibrate water temperature sensors on each side of coil to be within 0.2 degree F of each other.
      b. Turn off air handler fans, close outside air dampers. Keep pump running. Make sure appropriate coil dampers are open.
      c. Normally closed valves will close.
      d. Override normally open valves to the closed position.
      e. After 10 minutes observe water delta T across coil. If it is greater than 2 degrees F (, leakage is probably occurring.
      f. Reset valve stroke to close tighter.
      g. Repeat test until compliance is achieved.
   2. Method 2 - Air Temperature With 2 or 3-Way Valve: Water leak-by less than 10 percent will likely not be detected with this method.
      a. Calibrate air temperature sensors on each side of coil to be within 0.2 degree F of each other.
      b. Air handler fans should be on.
      c. Change mixed or discharge air setpoint, override values or bleed or squeeze bulb pneumatic controller to cause the valve to close.
      d. After 5 minutes observe air delta T across coil. If it is greater than one degree F (, leakage is probably occurring.
      e. Reset valve stroke to close tighter.
      f. Repeat test until compliance is achieved.
   3. Method 3 - Coil Drain Down: Not for 3-way valves.
      a. Put systems in normal mode.
      b. If cooling coil valve, remove all call for cooling; if heating coil valve, put system in full cooling.
      c. Close isolation valve on supply side of coil, open air bleed cap, open drain-down cock and drain water from coil.
      d. If water does not stop draining, there may be a leak through the control valve.

e. Return all to normal when done.

F. Isolation Valve or System Valve Leak Check: For valves not by coils.
   1. With full pressure in the system, command valve closed.
   2. Use an ultra-sonic flow meter to detect flow or leakage.

G. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

3.03 TAB COORDINATION

A. TAB: Testing, adjusting, and balancing of HVAC.

B. Coordinate commissioning schedule with TAB schedule.

C. Review the TAB plan to determine the capabilities of the control system toward completing TAB.

D. Provide all necessary unique instruments and instruct the TAB technicians in their use; such as handheld control system interface for setting terminal unit boxes, etc.

E. Have all required Prefunctional Checklists, calibrations, startup and component Functional Tests of the system completed and approved by the Commissioning Authority prior to starting TAB.

F. Provide a qualified control system technician to operate the controls to assist the TAB technicians or provide sufficient training for the TAB technicians to operate the system without assistance.

3.04 CONTROL SYSTEM FUNCTIONAL TESTING

A. Prefunctional Checklists for control system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of the Contract Documents and the detailed Sequences of Operation documentation submittal.

B. Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with the contract documents.

C. Using a skilled technician who is familiar with this building, execute the Functional Testing of the control system as required by the Commissioning Authority.

D. Functional Testing of the control system constitutes demonstration and trend logging of control points monitored by the control system.
   1. The scope of trend logging is partially specified; trend log up to 50 percent more points than specified at no extra cost to Owner.
   2. Perform all trend logging specified in Prefunctional Checklists and Functional Test procedures.

E. Functionally Test integral or stand-alone controls in conjunction with the Functional Tests of the equipment they are attached to, including any interlocks with other equipment or systems; further testing during control system Functional Test is not required unless specifically indicated below.

F. Demonstrate the following to the Commissioning Authority during testing of controlled equipment; coordinate with commissioning of equipment.
   1. Setpoint changing features and functions.
   2. Sensor calibrations.

G. Demonstrate to the Commissioning Authority:
   1. That all specified functions and features are set up, debugged and fully operable.
   2. That scheduling features are fully functional and setup, including holidays.
   3. That all graphic screens and value readouts are completed.
   4. Correct date and time setting in central computer.

5. That field panels read the same time as the central computer; sample 10 percent of field panels; if any of those fail, sample another 10 percent; if any of those fail test all remaining units at no extra cost to Owner.
6. Functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad; demonstrate 100 percent of panels and 10 percent of ports; if any ports fail, sample another 10 percent; if any of those fail, test all remaining units at no extra cost to Owner.
7. Power failure and battery backup and power-up restart functions.
8. Global commands features.
9. Security and access codes.
10. Occupant over-rides (manual, telephone, key, keypad, etc.).
11. O&M schedules and alarms.
12. Occupancy sensors and controls.
13. All control strategies and sequences not tested during controlled equipment testing.

H. If the control system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

3.05 OPERATION AND MAINTENANCE MANUALS

A. See Section 01 7800 for additional requirements.

B. Add design intent documentation furnished by Architect to manuals prior to submission to Owner.

C. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.

D. Commissioning Authority will add commissioning records to manuals after submission to Owner.

3.06 DEMONSTRATION AND TRAINING

A. Demonstrate operation and maintenance of HVAC system to Owner' personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.

B. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Authority during Functional Testing.

C. Provide classroom and hands-on training of Owner's designated personnel on operation and maintenance of the HVAC system, control system, and all equipment items indicated to be commissioned. Provide the following minimum durations of training:

D. TAB Review: Instruct Owner's personnel for minimum 8 hours, after completion of TAB, on the following:
1. Review final TAB report, explaining the layout and meanings of each data type.
2. Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
3. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
4. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
5. Other salient information that may be useful for facility operations, relative to TAB.

E. HVAC Control System Training: Perform training in at least three phases:
1. Phase 1 - Basic Control System: Provide minimum of 8 hours of actual training on the control system itself. Upon completion of training, each attendee, using appropriate

documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
    a. This training may be held on-site or at the manufacturer's facility.
    b. If held off-site, the training may occur prior to final completion of the system installation.
    c. For off-site training, Contractor shall pay expenses of up to two attendees.
2. Phase 2 - Integrating with HVAC Systems: Provide minimum of 8 hours of on-site, hands-on training after completion of Functional Testing. Include instruction on:
    a. The specific hardware configuration of installed systems in this facility and specific instruction for operating the installed system, including interfaces with other systems, if any.
    b. Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
    c. Trend logging and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends; provide practice in setting up trend logging and monitoring during training session.
    d. Every display screen, allowing time for questions.
    e. Point database entry and modifications.
3. Phase 3 - Post-Occupancy: Six months after occupancy conduct minimum of 4 hours of training. Tailor training session to questions and topics solicited beforehand from Owner. Also be prepared to address topics brought up and answer questions concerning operation of the system.

F. Provide the services of manufacturer representatives to assist instructors where necessary.

G. Provide the services of the HVAC controls instructor at other training sessions, when requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

END OF SECTION 230800

SECTION 232115 - GROUND-LOOP GEOTHERMAL 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 for vertical, direct-buried, ground-loop, heat-pump systems that operate between 23 and 104 deg F (minus 5 and plus 40 deg C).

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
   1. Ground-Loop, Geothermal Piping: 250 psig (1380 kPa).

1.4 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Pipe and fittings.
   2. Joining method and equipment.
   3. Methanol glycol solution.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.
B. 48 Hour thermal conductivity report.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS

A. PE Pipe: ASTM D 2239, SIDR Numbers 5.3, 7, 9, or 11.5; with PE compound number required to achieve required system working pressure.
   1. Molded PE Fittings: ASTM D 2683 or ASTM D 3261, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.
B. U-Bend Assembly: Factory fabricated with embossed depth stamp every 24 inches (600 mm) from U-bend.

2.2 BOREHOLE BACKFILL

A. Surface Seal: Bentonite with thermal conductivity greater than 1.2 Btu/h x sq. ft. x deg F (0.7 W/sq. m x K).
B. Backfill below Surface Seal: Natural or manufactured sand specified in Division 31 Section "Earth Moving."

2.3 ANTIFREEZE SOLUTION

A. Methanol Glycol: Minimum 20 percent methanol glycol with corrosion inhibitors and environmental stabilizer additives to be mixed with water to protect the piping circuit and connected equipment from physical damage from freezing or corrosion.

B. Quantity: Sufficient solution for initial system startup and for preventive maintenance for one year from date of Substantial Completion.
C. Dilution Water: Chloride content shall be less than 25 ppm, sulfate less than 25 ppm, and hardness less than 100 ppm.

PART 3 - EXECUTION

3.1 EXISTING LANDSCAPE WORK

A. Provide a replacement-in-kind of all the landscape components on the adjacent parcel made necessary by the geothermal work to include, but not be limited to, fencing, lighting, sidewalks, planting, soils, steps, railings, etc.

3.2 EARTHWORK

A. Excavating, trenching, warning tape, and backfilling are specified in Division 31 Section "Earth Moving."

3.3 VERTICAL PIPING INSTALLATION

A. Install PE piping in boreholes according to ASTM D 2774 or ASTM F 645.
   1. Clean PE pipe and fittings and make heat-fusion joints according to ASTM D 2657. Minimize number of joints.
B. Purge, flush, and pressure test piping before backfilling boreholes.
C. After installation of loop pipe in borehole, fill piping loop with water or antifreeze solution, and pump backfill into borehole to discharge at base of borehole.
D. Fill borehole with backfill to a point at least 84 inches (1524 mm] below grade and backfill remainder with surface seal material.
E. Extend piping and connect to water-source, ground-loop, heat-pump piping systems at outside face of building wall in locations and pipe sizes indicated.
   1. Terminate water-service piping at building wall until building water-source, ground-loop, heat-pump piping systems are installed. Terminate piping with caps. Make connections to building water-source, ground-loop, heat-pump piping systems when those systems are installed.
F. Wall sleeves are specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."
G. Mechanical sleeve seals are specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

3.4 ANTIFREEZE SOLUTION FILL

A. Fill system with required quantity of methanol glycol and water to provide minus 10 deg F (minus 23 deg C) freezing temperature.
B. Test the dilute solution using gas chromatography to verity concentration of propylene glycol, and forward report to Architect.

3.5 CONNECTIONS

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

3.6 TESTING

A. 48 Hour Thermal Conductivity Test: A 48 hour thermal conductivity test of the soil and soft rock is to be conducted to determine the thermal conductivity of the geothermal well site. Thermal conductivity test shall be administered in accordance with ASTM D5334-14, Standard Test Method for Determination of Thermal Conductivity of Soil and Soft Rock

by Thermal Needle Probe Procedure. Conductivity test report is to be provided to engineer for approval prior to final geothermal design submittal submission.

B. Piping Tests: Fill piping 24 hours before testing and apply test pressure to stabilize piping. Use potable water only.

C. Hydrostatic Tests: Test at not less than 1-1/2 times the pipe working-pressure rating allowing for static pressure of borehole depth.

1. Increase pressure in 50-psig (345-kPa) increments and inspect each joint between increments. Hold at test pressure for 30 minutes. Slowly increase to next test pressure increment and hold for 30 minutes. After testing at maximum test pressure, reduce pressure to 30 psig (207 kPa). Hold for 90 minutes, and measure pressure at 30-minute intervals. Repair leaks and retest until no leaks exist.

D. Prepare reports of testing activity.

END OF SECTION 232115

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. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
2. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
3. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:

1. Thermostatic expansion valves.
2. Solenoid valves.
3. Hot-gas bypass valves.
4. Filter dryers.
5. Strainers.
6. Pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

1. Shop Drawing Scale: [1/4 inch equals 1 foot (1:50)] <Insert value>.
2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.8 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.9 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K or L (ASTM B 88M, Type A or B).

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).

5. Maximum Operating Temperature: 250 deg F (121 deg C).

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; Type, Grade, and wall thickness as selected in Part 3 piping applications articles.

B. Wrought-Steel Fittings: ASTM A 234/A 234M, for welded joints.

C. Steel Flanges and Flanged Fittings: ASME B16.5, steel, including bolts, nuts, and gaskets, bevel-welded end connection, and raised face.

D. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

E. Flanged Unions:

1. Body: Forged-steel flanges for NPS 1 to NPS 1-1/2 (DN 25 to DN 40) and ductile iron for NPS 2 to NPS 3 (DN 50 to DN 80). Apply rust-resistant finish at factory.
2. Gasket: Fiber asbestos free.
3. Fasteners: Four plated-steel bolts, with silicon bronze nuts. Apply rust-resistant finish at factory.
4. End Connections: Brass tailpiece adapters for solder-end connections to copper tubing.
5. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
6. Pressure Rating: Factory test at minimum 400 psig (2760 kPa).
7. Maximum Operating Temperature: 330 deg F (165 deg C).

F. Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, stainless-steel-wire-reinforced protective jacket
2. End Connections:

    a. NPS 2 (DN 50) and Smaller: With threaded-end connections.
    b. NPS 2-1/2 (DN 65) and Larger: With flanged-end connections.

3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

2.3 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig (3450 kPa).

7. Maximum Operating Temperature: 275 deg F (135 deg C).

B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig (3450 kPa).
8. Maximum Operating Temperature: 275 deg F (135 deg C).

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig (3.4 kPa).
8. Working Pressure Rating: 500 psig (3450 kPa).
9. Maximum Operating Temperature: 275 deg F (135 deg C).

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig (3450 kPa).

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and [24] [115] [208]-V ac coil.
6. Working Pressure Rating: 400 psig (2760 kPa).
7. Maximum Operating Temperature: 240 deg F (116 deg C).
8. Manual operator.

F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat Disc: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig (2760 kPa).
6. Maximum Operating Temperature: 240 deg F (116 deg C).

G. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: [40 deg F (4.4 deg C)] <Insert temperature>.
6. Superheat: [Adjustable] [Nonadjustable].
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: [700 psig (4820 kPa)] [450 psig (3100 kPa)] <Insert value>.

H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
5. Seat: Polytetrafluoroethylene.
6. Equalizer: [Internal] [External].
7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and [24] [115] [208]-V ac coil.
8. End Connections: Socket.
9. Set Pressure: <Insert psig (kPa).>
10. Throttling Range: Maximum 5 psig (34 kPa).
11. Working Pressure Rating: 500 psig (3450 kPa).
12. Maximum Operating Temperature: 240 deg F (116 deg C).

I. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig (3450 kPa).
5. Maximum Operating Temperature: 275 deg F (135 deg C).

J. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig (3450 kPa).
6. Maximum Operating Temperature: 275 deg F (135 deg C).

K. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig (3450 kPa).
7. Maximum Operating Temperature: 240 deg F (116 deg C).

L. Replaceable-Core Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated [alumina] [charcoal].
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: [2 psig (14 kPa)] <Insert value>.
8. Rated Flow: <Insert tons (kW).>
9. Working Pressure Rating: 500 psig (3450 kPa).
10. Maximum Operating Temperature: 240 deg F (116 deg C).

M. Permanent Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated [alumina] [charcoal].
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: [2 psig (14 kPa)] <Insert value>.
8. Rated Flow: <Insert tons (kW).>
9. Working Pressure Rating: 500 psig (3450 kPa).
10. Maximum Operating Temperature: 240 deg F (116 deg C).

N. Mufflers:

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or flare.
3. Working Pressure Rating: 500 psig (3450 kPa).
4. Maximum Operating Temperature: 275 deg F (135 deg C).

O. Receivers: Comply with ARI 495.

1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig (3450 kPa).
7. Maximum Operating Temperature: 275 deg F (135 deg C).

P. Liquid Accumulators: Comply with ARI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig (3450 kPa).
4. Maximum Operating Temperature: 275 deg F (135 deg C).

2.4 REFRIGERANTS

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

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

1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 1-1/2 (DN 40) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed soldered joints.

B. Suction Lines NPS 3-1/2 (DN 90) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR L (B), drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Suction Lines: NPS 4 (DN 100) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR K (A), drawn-temper tubing and wrought-copper fittings with soldered joints.

D. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR L (B), annealed- or drawn-temper tubing and wrought-copper fittings with brazed soldered joints.

E. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

F. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications NPS 2 to NPS 4 (DN 50 to DN 100), Schedule 40, black-steel and wrought-steel fittings with welded joints.

G. Safety-Relief-Valve Discharge Piping: Copper, Type ACR L (B), annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. 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.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Hot-gas bypass valves.
4. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.

L. Install receivers sized to accommodate pump-down charge.

M. 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. Refer to Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. 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.

P. When brazing or soldering, 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.

Q. 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.

R. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

S. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

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. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. 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.

F. Threaded Joints: Thread steel 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.

G. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.

H. Welded Joints: Construct joints according to AWS D10.12/D10.12M.

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

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section "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 (6 m) long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet (6 m) or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2 (DN 15): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
2. NPS 5/8 (DN 18): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
3. NPS 1 (DN 25): Maximum span, 72 inches (1800 mm); minimum rod size, 1/4 inch (6.4 mm).
4. NPS 1-1/4 (DN 32): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
5. NPS 1-1/2 (DN 40): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
6. NPS 2 (DN 50): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
7. NPS 2-1/2 (DN 65): Maximum span, 108 inches (2700 mm); minimum rod size, 3/8 inch (9.5 mm).
8. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
9. NPS 4 (DN 100): Maximum span, 12 feet (3.7 m); minimum rod size, 1/2 inch (13 mm).

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 2 (DN 50): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
2. NPS 2-1/2 (DN 65): Maximum span, 11 feet (3.4 m); minimum rod size, 3/8 inch (9.5 mm).
3. NPS 3 (DN 80): Maximum span, 12 feet (3.7 m); minimum rod size, 3/8 inch (9.5 mm).
4. NPS 4 (DN 100): Maximum span, 14 feet (4.3 m); minimum rod size, 1/2 inch (13 mm).

E. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "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.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 233113 - DUCTWORK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal ductwork.
   2. Nonmetal ductwork.

1.2 RELATED SECTIONS

A. Section 230529 – Hangers and Supports.

B. Section 230700 - Duct Insulation: External insulation and duct liner.

C. Section 233300 - Ductwork Accessories.

D. Section 233713 - Air inlets and Outlets.

E. Section 230593 - Testing, Adjusting and Balancing.

1.3 REFERENCES

A. ASTM A 36 - Structural Steel.

B. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.

C. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

D. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.

E. SMACNA - HVAC Air Duct Leakage Test Manual.

F. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

G. UL 181 - Factory-Made Air Ducts and Connectors.

1.4 PERFORMANCE REQUIREMENTS

A. No variation of duct configuration or sizes permitted except by written permission.

1.5 SUBMITTALS

A. Submit under provisions of Division 1.

B. Shop Drawings: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work for 4 inch pressure class and higher, and kitchen hood exhaust systems.

C. Product Data: Provide data for duct materials, duct liner and duct connectors.

D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1.

B. Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing the work of this section with minimum five years documented experience.

1.9 REGULATORY REQUIREMENTS

A. Construct ductwork to NFPA 90A, NFPA 90B and NFPA 96 standards.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures during and after installation of duct sealants.

PART 2 PRODUCTS

2.1 MATERIALS

A. Galvanized Steel Ducts: ASTM A525 and ASTM A527 galvanized steel sheet, lock-forming quality, having zinc coating of in conformance with ASTM A90.

B. Flexible Ducts:
1. Manufacturers: See Section 233300.
2. Two ply vinyl film supported by helically wound spring steel wire.
3. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
4. Maximum Velocity: 4000 fpm.
5. Temperature Range: -20 to 180 degrees F.

C. Fasteners: Rivets, bolts, or sheet metal screws.

D. Sealant:
1. Manufacturers:
   a. United McGill.
2. Non-hardening, water resistant, fire resistive, compatible with mating materials; liquid used alone or with tape, or heavy mastic.

E. Hanger Rod: ASTM A36; steel, galvanized (in wet locations); threaded both ends, threaded one end, or continuously threaded.

2.2 DUCTWORK FABRICATION

A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide air foil turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.

C. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 30 degrees convergence downstream.

D. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Joints shall be minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.

E. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.

2.3 MANUFACTURED DUCTWORK AND FITTINGS

A. Manufacture in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. Round Spiral Ducts:
   1. Manufacturers:
      a. United McGill.
      b. SEMCO.
   2. Machine made from round spiral lockseam duct with light reinforcing corrugations; fittings manufactured of at least two gages heavier metal than duct.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions and in accordance with SMACNA HVAC Duct Construction Standards.

B. Install and seal ducts and all galvanized duct joints in accordance with SMACNA HVAC Duct Construction Standards, seal Class B with water based sealant by United McGill.

C. All duct dimensions shown on drawings are clear inside dimensions. Increased duct sizes to allow for insulation as specified.

D. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete

with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

F. Use double nuts and lock washers on threaded rod supports.

G. Slope underground ducts to low points at l:500.

H. Connect flexible ducts to metal ducts per flexible duct manufacturers recommendations.

I. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

J. Access doors shall be installed in ducts at all points shown on drawings or specified herein, and wherever necessary to provide access to adjustable accessories installed in ductwork.

K. Duct shall be relocated as necessary to miss building obstructions.

L. It shall be the responsibility of the MC to carefully review architectural plans and site conditions to maintain proper clearances.

3.2 CLEANING

A. Clean work under provisions of Division 1.

B. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

3.3 SCHEDULES

A. See schedule on drawings.

END OF SECTION 233113

SECTION 233300 - DUCTWORK ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Air turning devices.
2. Backdraft dampers.
3. Fire dampers
4. Duct access doors.
5. Duct test holes.
6. Flexible duct connections.
7. Volume control dampers.
8. Louvers.
9. Duct Detectors.

B. RELATED SECTIONS
1. Section 233113 - Ductwork.
2. Section 262800 – Wiring Connections: Electrical characteristics and wiring connections.

1.2 REFERENCES

A. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

B. NFPA 92A - Smoke Control Systems.

C. NFPA 70 - National Electrical Code.

D. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

1.3 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data: Provide for shop fabricated assemblies.

C. Manufacturer's Installation Instructions: Provide for all dampers.

1.4 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 3 years experience.

1.6 REGULATORY REQUIREMENTS

A. Fire dampers: Listed and classified by Underwriters' Laboratories Inc., as suitable for the purpose specified and indicated. All fire dampers shall be Dynamic type.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 1.

B. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.1 AIR TURNING DEVICES

A. Single thickness, constructed to SMACNA standards for a pressure loss coefficient of 0.24.

2.2 BACKDRAFT DAMPERS (Barometric Type)

A. Manufacturers:
1. Greenheck.
2. Ruskin.

B. Backdraft dampers size 18 x 18 inches or smaller and furnished with Air Moving Equipment: Provide Air Moving Equipment manufacturer's standard low leakage construction.

C. Backdraft dampers installed in duct: Shall be counterbalancing type with adjustable counterbalance for adjusting pressure differential required to open damper, with flangeless frame for duct mounting, 0.063 thick 6063T5 extruded aluminum frame, 0.050 thick 6063T5 extruded aluminum blades with vinyl seals on closing edge, 3/16” diameter zinc plated axles mounted in acetal bushings, 20 gauge galvanized tie bar counterbalances, welded corners.

2.3 FIRE DAMPERS.

A. Manufacturers:
1. Ruskin.
2. Cesco.

B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.

C. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations with closure under air flow conditions (dynamic). Configure with blades out of air stream.

D. Multiple Blade Dampers: 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.

E. Fusible Links: UL 33, separate at 165 degrees F for cooling only ducts and 212 degrees F for heating/cooling ducts.

2.4 DUCT ACCESS DOORS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

B. Fabrication: Rigid and close-fitting, of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.
   1. Less Than 12 Inches Square: Secure with sash locks.
   2. Up to 18 Inches Square: Provide two hinges and two sash locks.
   3. Up to 24 x 48 Inches: Three hinges and two compression latches.

C. Access doors with sheet metal screw fasteners are not acceptable.

2.5 DUCT TEST HOLES

A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.6 FLEXIBLE DUCT CONNECTIONS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

B. Connector: Fabric crimped into metal edging strip.
   1. Fabric: UL listed fire-retardant, neoprene coated, woven glass fiber fabric.
   2. Net Fabric Width: 3 inches, minimum.

2.7 MANUAL VOLUME CONTROL DAMPERS.

A. Manufacturers:
   1. Ruskin.
   2. Arrow.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

C. Single Blade Dampers: 20 gauge galvanized steel with spring end bearing and lockable quadrant.

D. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch Assemble center and edge crimped blades in 16 gauge galvanized channel frame with suitable hardware.

E. End Bearings: Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings;

F. Quadrants:
   1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
   2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
   3. Where rod lengths exceed 30 inches, provide regulator at both ends.

2.8 LOUVERS

A. Manufacturers

1. Ruskin.
2. Greenheck.

B. Louvers shall be stationary type. Stationary blades shall be contained within a single 4" frame. Louver components(heads, jambs, sills, blades and mullions) shall be factory assembled by the louver manufacturer. Louver design shall incorporate structural supports required to withstand a wind load of 20 psf. Water penetration shall be less than 0.01 oz./sq.ft. at less than 840 fpm.
1. Frames : 0.081" extruded aluminum wall thickness.
2. Blades : 0.081" extruded aluminum wall thickness at 37-1/2 degrees on approximately 3" centers.
3. Screens : 3/4" x 0.051" expanded flattened aluminum in removable frame.

C. Louvers shall be finished to match the building material in which they are installed; coordinate finish with the Architect.

2.9 CONTROL DAMPERS

A. Manufacturers
1. Ruskin.
2. Greenheck.
3. Arrow.

B. Construction: 16 gauge galvanized steel hat channel frame with 14 gauge equivalent thickness double skin airfoil construction blades, 6” width with blade extensions optional to meet size requirements. Seals shall be extruded vinyl blade edga inflatable type mechanically locked into blade for leakage of 6.0 cfm or less at 2” w.c. and 36” damper width. bearings shall be stainless steel sleeve type, and axles shall be 1/2” plated steel.

2.10 DUCT DETECTORS

A. Duct detectors shall be furnished by the electrical contractor and installed by the mechanical contractor.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 233113 for duct construction and pressure class. Install silencers to have a pressure drop multiplier factor of 1.0 according to manufacturer’s literature, and to meet performance scheduled on drawings. Refer to Section 233113 for duct construction and pressure class.

B. Provide motorized backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, and elsewhere as indicated. Provide 18 x 18 inch size for shoulder access where duct size allows. Review locations prior to fabrication.

D. Provide duct test holes where indicated and/or required for testing and balancing purposes.

E. Provide fire dampers and associated access doors at locations indicated, where ducts and outlets pass through fire rated components. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

F. Demonstrate re-setting of fire dampers to Owner's representative.

G. Provide flexible connections on both sides of all air handling units, exhaust fans, and where shown on drawings.

H. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing, and where shown on drawings. Provide opposed blade dampers with 6 inch blades where balance dampers are required in ducts 18 X 12 or larger.

I. Two position automatic control dampers shall be parallel blade. Modulating control dampers shall be opposed blade, except dampers in return and outside air ducts that constitute mixed air shall be parallel or opposed blade as required to effect mixing of the airstreams.

END OF SECTION 233300

SECTION 233416 - FANS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The Contract Documents, as defined within Division 1 - Construction Agreement, apply to the Work of this Section. Additional requirements and information necessary to complete the Work of this Section may be found in other documents.

1.2 SUMMARY

A. Section Includes:
   1. Centrifugal In-line Fan
   2. Roof Mounted Fan

B. Related Sections:
   1. Section 262800 - Wiring Connections: Execution and product requirements for connecting equipment specified by this section.

C. Related Sections:
   1. Related Green Building and PHFA Criteria:
      a. All exhaust fans to be ENERGY STAR labeled, or shall conform to meet the ENERGY STAR standard 2.8 CFM/W energy efficiency requirement.

1.3 REFERENCES

A. American Bearing Manufacturers Association:
   1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. Air Movement and Control Association International, Inc.:
   1. AMCA 99 - Standards Handbook.
   2. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
   3. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
   4. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

C. National Electrical Manufacturers Association:
   1. NEMA MG 1 - Motors and Generators.

D. Underwriters Laboratories Inc.:
   1. UL 705 - Power Ventilators.

1.4 SUBMITTALS

A. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork and accessory connections.

B. Product Data: Submit data on fans and accessories including fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.

C. Manufacturer's Installation Instructions: Submit fan manufacturers instructions.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Division 1 - Project Closeout: Closeout procedures.

B. Division 1 - Operation and Maintenance Data: Manuals for equipment.

C. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Division 1 - Material and Equipment: Product storage and handling requirements.

B. Protect motors, shafts, and bearings from weather and construction dust.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 WARRANTY

A. Division 1 - Warranties and Bonds: Product warranties and product bonds.

B. Furnish one year manufacturer’s warranty for fans.

1.10 EXTRA MATERIALS

A. Division 1 - Project Closeout: Spare parts and maintenance products.

B. Furnish two sets of belts for each fan.

PART 2 PRODUCTS

2.1 Centrifugal In-Line Fans

A. Manufacturers:
   1. Cook.
   2. Equal by:

a. Greenheck.
b. ACME.

B. Product Description:
1. Duct mounted supply, exhaust or return fans shall be of centrifugal belt driven in-line type. The fan housing shall be of the square design constructed of heavy gauge galvanized steel and shall include square duct mounting collars.
2. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced.
3. Motors shall be heavy duty ball bearing type, carefully matched to the fan load and furnished at the specified voltage, phase and enclosure. Motors and drives shall be mounted out of the airstream. Motors shall be readily accessible for maintenance.
4. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum (L50) life in excess of 200,000 hours at maximum cataloged operating speed.
5. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
6. Motor pulleys shall be adjustable for system balancing. A NEMA 1 disconnect switch shall be provided as standard, except with explosion resistant motors, where disconnects are optional. Factory wiring shall be provided from motor to the handy box.
7. All fans shall bear the AMCA Certified Ratings Seal for both sound and air performance.
8. Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification.

C. Accessories:
1. Disconnect Switch: Factory-wired, non-fusible, in housing for thermal overload protected motor.
2. Back-draft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked.
3. Vibration isolation pads and/or hangers.

D. Performance:
1. See Schedule on Drawings.

2.2 Roof Mounted Fans

A. Manufacturers:
1. Greenheck.
2. Equal by:
a. Cook.
b. ACME.

B. Product Description:
1. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced.
2. Motors shall be heavy duty ball bearing type, carefully matched to the fan load and furnished at the specified voltage, phase and enclosure. Motors and drives shall be mounted out of the airstream. Motors shall be readily accessible for maintenance.

3. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum (L50) life in excess of 200,000 hours at maximum cataloged operating speed.
4. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
5. Motor pulleys shall be adjustable for system balancing. A NEMA 1 disconnect switch shall be provided as standard, except with explosion resistant motors, where disconnects are optional. Factory wiring shall be provided from motor to the handy box.
6. All fans shall bear the AMCA Certified Ratings Seal for both sound and air performance.
7. Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification.

C. Accessories:
1. Disconnect Switch: Factory-wired, non-fusible, in housing for thermal overload protected motor.
2. Back-draft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked.
3. 14” standard roof curb.

D. Performance:
1. See Schedule on Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 1 - Coordination - Multiple Prime Contracts: Coordination and project conditions.

3.2 INSTALLATION

A. Install motorized backdraft dampers on inlet to exhaust fans.

B. Install safety screen where inlet or outlet is exposed.

C. Provide sheaves required for final air balance.

3.3 CLEANING

A. Division 1 - Coordination - Multiple Prime Contracts: Requirements for cleaning.

B. Vacuum clean inside of fan cabinet.

3.4 DEMONSTRATION

A. Division 1 - Operation and Maintenance Data: Instruction of Owner personnel.

B. Demonstrate fan operation.

3.5 PROTECTION OF FINISHED WORK

A. Division 1 - Coordination - Multiple Prime Contracts: Requirements for protecting finished Work.

B. Do not operate fans for until ductwork is clean, bearings lubricated, and fan has been test run under observation.

3.6 SCHEDULES

A. See drawings for fan schedules.

END OF SECTION 233416

SECTION 233713 - AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Diffusers.
   2. Registers/grilles.
   3. Louvers.

1.2 REFERENCES

A. ADC 1062 - Certification, Rating and Test Manual.

B. AMCA 500 - Test Method for Louvers, Dampers and Shutters.

C. ARI 650 - Air Outlets and Inlets.

D. ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Outlets and Inlets.

E. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

F. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

1.3 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, pressure drop, application, and noise level.

1.4 QUALITY ASSURANCE

A. Test and rate air outlet and inlet performance in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.

B. Test and rate louver performance in accordance with AMCA 500.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 5 years experience.

PART 2 PRODUCTS

2.1 CEILING DIFFUSERS

A. Manufacturers:
   1. Price.
   2. Other acceptable manufacturers offering equivalent products.

a. Kreuger.
b. Anemostat.

B. Type: Square, die-stamped, diffuser to discharge air in 360 degree four way pattern. Provide with round-necked accessory.

C. Frame: Surface mount or Inverted T-bar, as required.

D. Fabrication: Aluminum with finish selected by architect.

2.2 WALL DIFFUSERS

A. Manufacturers:
1. Price.
2. Other acceptable manufacturers offering equivalent products.
a. Kreuger.
b. Anemostat.

B. Type: Double-deflection, square louver with front blades parallel to long dimension. Coordinate duct connection sizes with manufacturer's recommendations.

C. Frame: Surface mount or Inverted T-bar, as required.

D. Fabrication: Aluminum with finish selected by architect.

2.3 LINEAR BAR DIFFUSERS

A. Manufacturers:
1. Price.
2. Other acceptable manufacturers offering equivalent products.
a. Kreuger.
b. Anemostat.

B. Type: Extruded aluminum, deflection as specified on schedule. Suitable for use as supply or return. Coordinate duct connection sizes with manufacturer's recommendations.

C. Frame: As required for mounting. Provide concealed frames on overhead ducts.

D. Finish: Selected by architect.

2.4 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

A. Manufacturers:
1. Price.
2. Other acceptable manufacturers offering equivalent products.
a. Kreuger.
b. Anemostat.

B. All aluminum, 1/2 inch blade spacing, all blades individually adjustable. Finish selected by Architect.

2.5 DIFFUSERS - LINEAR SLOTS

A. Manufacturers:
1. Price.

2. Other acceptable manufacturers offering equivalent products.
   a. Kreuger.
   b. Anemostat.

B. Type: Aluminum modulinear with adjustible pattern controller.

C. Frame: Frame and border type 2A (Flange border and concealed mounting). End fabrication to be style X (border end). Coordinate duct connection sizes with manufacturers recommendations.

D. Fabrication: Aluminum with finish selected by Architect.

2.6 LOUVERS

A. Manufacturers:
   1. Ruskin.
   2. Substitutions: Division 1 - Product Requirements.

B. Product Description: Thin Line Stationary Louver.

C. Type: 2 inch deep with blades on 35 degree slope and return bend, heavy channel frame.

D. Fabrication: 6063T5 extruded aluminum with 0.060” nominal wall thickness with baked enamel finish, color per architect.

E. Mounting: Furnish with exterior flat flange for installation.

F. Bird Screen: Bird screen with 1/2 inch square mesh for exhaust and 3/4 inch for intake.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

C. Install diffusers to ductwork with air tight connection.

D. Coordinate RGD frame type with wall and ceiling construction.

END OF SECTION 233713

SECTION 233723 - GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contract Documents, as defined within Division 1 - Construction Agreement, apply to the Work of this Section. Additional requirements and information necessary to complete the Work of this Section may be found in other documents.

1.2 SUMMARY

A. Section Includes:

1. Louvered-penthouse ventilators.
2. Roof hoods.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design ventilators, including comprehensive engineering analysis by a qualified professional engineer, using structural and seismic performance requirements and design criteria indicated.

B. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

1. Wind Loads: Determine loads based on pressures as indicated on Drawings.
2. Wind Loads: Determine loads based on a uniform pressure of 20 lbf/sq. ft. acting inward or outward.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.

1. Temperature Change (Range): 120 deg F ambient; 180 deg F material surfaces.

D. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. For louvered-penthouse ventilators specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Manufacturer's Installation Instructions: Submit fan manufacturer’s instructions.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

D. 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.

1.5 CLOSEOUT SUBMITTALS

A. Division 1 - Project Closeout: Closeout procedures.

B. Division 1 - Operation and Maintenance Data: Manuals for equipment.

C. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Division 1 - Material and Equipment: Product storage and handling requirements.

B. Protect motors, shafts, and bearings from weather and construction dust.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 WARRANTY

A. Division 1 - Warranties and Bonds: Product warranties and product bonds.

B. Furnish one year manufacturer’s warranty for fans.

1.10 EXTRA MATERIALS

A. Division 1 - Project Closeout: Spare parts and maintenance products.

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. Stainless-Steel Sheet: ASTM A 666, Type 304, with No. 4 finish.

E. 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 hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.

F. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

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 LOUVERED-PENTHOUSE VENTILATORS

A. Manufacturers:
1. Cook.
2. Equal by:
    a. Greenheck.

B. Construction: All-welded assembly with 6-inch -deep louvers, mitered corners, and galvanized-steel sheet roof with mineral-fiber insulation and vapor barrier.

C. Frame and Blade Material and Nominal Thickness: Extruded aluminum, of thickness required to comply with structural performance requirements, but not less than 0.080 inch for frames and 0.060 inch for blades with condensate deflectors.
   1. AMCA Seal: Mark units with the AMCA Certified Ratings Seal.
   2. Exterior Corners: Prefabricated corner units with mitered and welded blades and with fully recessed mullions at corners.

D. Frame and Blade Material and Nominal Thickness: Galvanized-steel sheet, of thickness required to comply with structural performance requirements, but not less than 0.052 inch for frames and 0.052 inch for blades with condensate deflectors.
   1. AMCA Seal: Mark units with the AMCA Certified Ratings Seal.
   2. Exterior Corners: Prefabricated corner units with mitered and welded blades and with fully recessed mullions at corners.

E. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) 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: 12 inches .

F. Bird Screening: Galvanized-steel, 1/2-inch square mesh, 0.041-inch wire.

G. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch wire.

H. 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.
   3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.

      a. Color and Gloss: [As selected by Architect from manufacturer's full range].

I. Accessories:

   1. Dampers:

      a. Location: Penthouse neck .
      b. Control: Motorized.

J. Capacities and Characteristics:

   1. Height: See drawings for gravity ventilator height.
   2. Width and Depth: See drawings for gravity ventilator width and depths.

3. Wind-Driven Rain Performance: Not less than 95 percent effectiveness when subjected to a rainfall rate of 3 inches per hour and a wind speed of 29 mph at a core-area intake velocity of 400 fpm .

2.4 ROOF HOODS

A. Manufacturers:
   1. Cook.
   2. Equal by:
      b. Greenheck.

B. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 6-6 and 6-7.

C. Materials: Galvanized-steel sheet, minimum 0.064-inch thick base and 0.040-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: 12 inches.

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.
   3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils .

      a. Color and Gloss: As selected by Architect from manufacturer's full range.

H. Capacities and Characteristics:

   1. Height: See drawings for gravity ventilator height.
   2. Width and Depth: See drawings for gravity ventilator width and depths

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 "Ductwork". Drawings indicate general arrangement of ducts and duct accessories.

3.3 ADJUSTING

A. Adjust damper linkages for proper damper operation.

3.4 DEMONSTRATION

A. Division 1 – Coordination – Multiple Prime Contracts: Requirements for cleaning.

3.5 PROTECTION OF FINISHED WORK

A. Division 1 – Coordination – Multiple Prime Contracts: Requirements for protecting finished work.

3.6 SCHEDULES

A. See drawings for gravity ventilator schedules.

END OF SECTION 233723

SECTION 238126 - SPLIT SYSTEM HEAT PUMP UNITS

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 split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

F. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

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. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

E. All split system heat pumps to be ENERGY STAR labeled. The combination of indoor air handling unit and outdoor heat pump must be listed as ENERGY STAR compliant in the ENERGY STAR database.

1.5 COORDINATION

A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."

B. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in Division 7 Section "Roof Accessories."

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set of filters for each unit.
2. Fan Belts: One set of belts for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

1. Carrier Air Conditioning; Div. of Carrier Corporation.
2. Tempstar
3. Evcon Industries, Inc.
4. First Co.
5. Friedrich Air Conditioning Company.
6. Koldwave, Inc.
7. Lennox Industries Inc.
8. Mitsubishi Electric Sales Canada, Inc.
9. Mitsubishi Electronics America, Inc.; HVAC Division.
10. Mitsubishi Heavy Industries America, Inc.; Air-Conditioning & Refrigeration Division, Inc.
11. Sanyo Fisher (U.S.A.) Corp.

12. Tadiran Electronic Industries Inc.; Appliance Division.
13. Trane Company (The); Unitary Products Group.
14. York International Corp.

2.2 EVAPORATOR-FAN COMPONENTS

A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.

D. Fan: Direct drive, centrifugal fan.

E. Fan Motors: Comply with requirements in Division 15 Section "Motors."

1. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.

F. Filters: Permanent, cleanable.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

1. Compressor Type: Reciprocating or Scroll.
2. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
3. Refrigerant Charge: R-410.

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.

D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.

E. Fan: Aluminum-propeller type, directly connected to motor.

F. Motor: Permanently lubricated, with integral thermal-overload protection.

G. Hard Start Kit.

H. Low Ambient Kit: Permits operation down to 45 deg F (7 deg C).

I. Mounting Base: Polyethylene.

2.4 ACCESSORIES

A. Control equipment and sequence of operation are specified in Division 15 Sections "HVAC Instrumentation and Controls" and "Sequence of Operation."

B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

C. 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.

D. Automatic-reset timer to prevent rapid cycling of compressor.

E. 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.

F. Additional Monitoring:

1. Monitor constant and variable motor loads.
2. Monitor variable frequency drive operation.
3. Monitor economizer cycle.
4. Monitor cooling load.
5. Monitor air distribution static pressure and ventilation air volumes.

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 polyethylene mounting base or wolmanized lumber

D. Install seismic restraints.

E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Ground equipment according to Division 16 Section "Grounding and Bonding."

B. Electrical Connections: Comply with requirements in Division 16 Sections for power wiring, switches, and motor controls.

3.3 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. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

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.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Division 1 Section

END OF SECTION 238126

238136 - VARIABLE REFRIGERANT FLOW SYSTEM

Part 1 – General

1.1 SYSTEM DESCRIPTION

The variable capacity, heat pump heat recovery air conditioning system shall be a Mitsubishi Electric CITY MULTI VRF (Variable Refrigerant Flow) zoning system.

1.2 QUALITY ASSURANCE

A. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.

B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

C. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

D. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the proposed ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the DOE alternative test procedure, which is based on the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standards 340/360, 1230 and ISO Standard 13256-1.

E. A full charge of R-410A for the condensing unit only shall be provided in the condensing unit.

1.3 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer's recommendation.

1.4 CONTROLS

A. The control system shall consist of a low voltage communication network of unitary built-in controllers with on-board communications and a web-based operator interface. A web controller with a network interface card shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.

B. System controls and control components shall be installed in accordance with the manufacturer's written installation instructions.

C. Furnish energy conservation features such as optimal start, night setback, request-based logic, and demand level adjustment of overall system capacity as specified in the sequence.

D. System shall provide direct and reverse-acting on and off algorithms based on an input condition or group conditions to cycle a binary output or multiple binary outputs.

E. Provide capability for future system expansion to include monitoring and use of occupant card access, lighting control and general equipment control.

F. System shall be capable of email generation for remote alarm annunciation.

Control system start-up shall be a required service to be completed by the manufacturer or a duly authorized, competent representative that has been factory trained in Mitsubishi controls system configuration and operation. The representative shall provide proof of certification for Mitsubishi CMCN Essentials Training

and/or CMCN Hands-On Training indicating successful completion of no more than two (2) years prior to system installation. This certification shall be included as part of the equipment and/or controls submittals. This service shall be equipment and system count dependent and shall be a minimum of one (1) eight (8) hour period to be completed during normal working hoursPART 2 – WARRANTY

Part 2 – Warranty

2.01 The units shall be covered by the manufacturer's limited warranty for a period of one (1) year from date of installation.

If the systems are:

1) designed by a certified CITY MULTI Diamond Designer,

2) installed by a contractor that has successfully completed the Mitsubishi

Electric three day service course, AND

3) verified with a completed commissioning report submitted to and approved

by the Mitsubishi Electric Service Department,

then the units shall be covered by an extended manufacturer's limited warranty for a period of five (5) years from date of installation.

In addition the compressor shall have a manufacturer's limited warranty for a period of seven (7) years from date of installation.

If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer.

This warranty shall not include labor.

2.02 Manufacturer shall have a minimum of twenty-nine years of HVAC experience in the U.S. market.

2.03 All manufacturer technical and service manuals must be readily available for download by any local contractor should emergency service be required. Registering and sign-in requirements which may delay emergency service reference are not allowed.

2.04 The CITY MULTI VRF system shall be installed by a contractor with extensive CITY MULTI install and service training. The mandatory contractor service and install training should be performed by the manufacturer.

Part 3 – Products

3.01 R2-SERIES HYPER-HEATING OUTDOOR UNIT

A. General:

The R2-Series shall consist of the PURY-HP outdoor unit, indoor units, and M-NET DDC (Direct Digital Controls). The R2-Series hyper-heating outdoor unit shall be used specifically with CITY MULTI VRF components. The R2-Series PURY-HP outdoor units shall be equipped with multiple circuit boards that interface to the M-NET controls system and shall perform all functions necessary for operation. Each outdoor unit module shall be completely factory assembled, piped, wired and run tested at the factory.

1. The model nomenclature and unit requirements are shown below. All units requiring a factory supplied twinning kits shall be piped together in the field, without the need for equalizing line(s). If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor.

Outdoor Unit Model Nomenclature		
208/230 Volt		Twinning Kit
Model Number	Units	
PURY-HP72TKMU-A-H	(1) PURY-HP72TKMU-A-H	None
PURY-HP96TKMU-A-H	(1) PURY-HP96TKMU-A-H	None
PURY-HP144TSKMU-A-H	(2) PURY-HP72TKMU-A-H	CMY-R100CBK2
PURY-HP192TSKMU-A-H	(2) PURY-HP96TKMU-A-H	CMY-R100CBK2

2. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of outdoor rated capacity.

3. Outdoor unit shall have a sound rating no higher than 58 dB(A) individually or 61 dB(A) twinned. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.

4. Both refrigerant lines from the outdoor unit to the BC (Branch Circuit) Controller (Single or Main) shall be insulated.

5. There shall be no more than 3 branch circuit controllers connected to any one outdoor unit.

6. Outdoor unit shall be able to connect to up to 48 indoor units depending upon model.

7. The outdoor unit shall have an accumulator with refrigerant level sensors and controls.

8. The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.

9. The outdoor unit shall have the ability to operate with a maximum height difference of 164 feet and have total refrigerant tubing length of 1804-2625 feet. The greatest length is not to exceed 541 feet between outdoor unit and the indoor units without the need for line size changes or traps.

10. The outdoor unit shall have rated performance of heating operation at -13°F ambient temperatures and cooling mode down to 23°F ambient temperatures, without additional low ambient controls. The unit shall maintain 100% heat output at 0°F without a supplemental

heat source or a second compressor to boost low ambient heating performance. If an alternate manufacturer is selected, any additional material, cost, and labor to meet low ambient operating condition and performance shall be incurred by the contractor.

11. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.

12. The outdoor unit shall be provided with a manufacturer supplied 20 gauge hot dipped galvanized snow /hail guard. The snow/hail guard protects the outdoor coil surfaces from hail damage and snow build-up in severe climates.

13. Unit must defrost all circuits simultaneously in order to resume full heating more quickly. Partial defrost which may extend “no or reduced heating” periods shall not be allowed.

B. Heat Interchanger circuit.

1. The outdoor unit shall contain a heat interchanger circuit for sub-cooling liquid prior to entering the outdoor coil during the heating mode.

2. The interchanger shall be of a copper tube within a tube construction.

3. The interchanger circuit refrigerant flow shall be controlled by an electronic expansion valve.

C. Unit Cabinet:

1. The casing(s) shall be fabricated of galvanized steel, bonderized and finished.

D. Fan:

1. Each outdoor unit module shall be furnished with one direct drive, variable speed propeller type fan. The fan shall be factory set for operation under 0 in. WG external static pressure, but capable of normal operation under a maximum of 0.24 in. WG external static pressure via dipswitch.

2. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.

3. All fan motors shall be mounted for quiet operation.

4. All fans shall be provided with a raised guard to prevent contact with moving parts.

5. The outdoor unit shall have vertical discharge airflow.

E. Refrigerant

1. R410A refrigerant shall be required for PURY-HP-T/Y(S)KMU-A outdoor unit systems.

2. Polyolester (POE) oil shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.

F. Coil:

1. The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.

2. The coil fins shall have a factory applied corrosion resistant blue-fin finish.

3. The coil shall be protected with an integral metal guard.

4. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.

5. The outdoor coil shall include 4 circuits with two position valves for each circuit, except for the last stage.

G. Basepan Heater:

1. Each outdoor unit module shall be equipped with a basepan heater. Basepan heater shall activate only when compressor is operating in heating mode at an outdoor ambient temperature of 39F or below. If an alternate manufacturer is selected, any additional material, cost, and labor to meet basepan heater condition and performance shall be incurred by the contractor.

H. Compressor:

1. Each outdoor unit module shall be equipped with one inverter driven scroll hermetic compressor. Non inverter-driven compressors, which cause inrush current (demand charges) and require larger wire sizing, shall not be allowed.

2. A crankcase heater(s) shall be factory mounted on the compressor(s).

3. The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable with a turndown of 19%-5% of rated capacity, depending upon unit size.

4. The compressor will be equipped with an internal thermal overload.

5. The compressor shall be mounted to avoid the transmission of vibration.

6. Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.

I. Controls:

1. The outdoor unit shall have the capability of up to 8 levels of demand control for each refrigerant system

J. Electrical:

1. The outdoor unit electrical power shall be 208/230 volts, 3-phase, 60 hertz.

2. The outdoor unit shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz), 207-253V (230V/60Hz).

3. The outdoor unit shall be controlled by integral microprocessors.

4. The control circuit between the indoor units, BC Controller and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

3.02 BRANCH CIRCUIT (BC) CONTROLLERS FOR R2-SERIES SYSTEMS

A. General

The BC (Branch Circuit) Controllers shall include multiple branches to allow simultaneous heating and cooling by allowing either hot gas refrigerant to flow to indoor unit(s) for heating or subcooled liquid refrigerant to flow to indoor unit(s) for cooling. Refrigerant used for cooling must always be subcooled for optimal indoor unit LEV performance; alternate branch devices with no subcooling risk bubbles in liquid supplied to LEV and are not allowed.

The BC (Branch Circuit) Controllers shall be specifically used with R410A R2-Series systems. These units shall be equipped with a circuit board that interfaces to the M-NET controls system and shall perform all functions necessary for operation. The unit shall have a galvanized steel finish. The BC Controller shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. This unit shall be mounted indoors, with access and service clearance provided for each controller. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of rated capacity.

B. BC Unit Cabinet:

1. The casing shall be fabricated of galvanized steel.

2. Each cabinet shall house a liquid-gas separator and multiple refrigeration control valves.

3. The unit shall house two tube-in-tube heat exchangers.

C. Refrigerant

1. R410A refrigerant shall be required.

D. Refrigerant valves:

1. The unit shall be furnished with multiple branch circuits which can individually accommodate up to 54,000 BTUH and up to three indoor units. Branches may be twinned to allow more than 54,000 BTUH.

2. Each branch shall have multiple two-position valves to control refrigerant flow.

3. Service shut-off valves shall be field-provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation.

4. Linear electronic expansion valves shall be used to control the variable refrigerant flow.

E. Future Use

1. Each VRF system shall include at least one (1) unused branches or branch devices for future use. Branches shall be fully installed & wired in central location with capped service shutoff valve & service port.

F. Integral Drain Pan:

1. An Integral drain pan and drain shall be provided

G. Electrical:

1. The unit electrical power shall be 208/230 volts, 1 phase, 60 Hertz.

2. The unit shall be capable of satisfactory operation within voltage limits of 187-228 (208V/60Hz) or 207-253 (230/60Hz).

3. The BC Controller shall be controlled by integral microprocessors

4. The control circuit between the indoor units and outdoor units shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

3.03

PEFY-NMSU (LOW PROFILE CEILING-CONCEALED DUCTED) INDOOR UNIT

A. General:

The PEFY-NMSU (Low Profile) unit shall be a ceiling-concealed ducted indoor fan coil that mounts above the ceiling with a rear return and a fixed horizontal discharge supply and shall have a modulating linear expansion device. The PEFY-NMSU shall be used with the R2-Series outdoor unit and BC Controller, Y-Series outdoor unit, or S-Series outdoor unit. The PEFY-NMSU shall support individual control using M-NET DDC controllers. PEFY (Low Profile) models shall have an extremely compact profile (7-7/8") which requires minimal ceiling space. PEFY-NMSU models shall feature external static pressure settings up to 0.20 in. WG. Units shall have the ability to control supplemental heat via connector CN24 and a 12 VDC output.

B. Indoor Unit.

The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

C. Unit Cabinet:

1. The cabinet shall be space saving, low profile, ceiling-concealed ducted.

2. The cabinet panel shall have provisions for a field installed filtered outside air intake.

D. Fan:

1. The indoor unit fan shall be an assembly with one Sirocco fan direct driven by a single motor.

2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.

3. The indoor fan shall consist of three (3) speeds, High, Mid, and Low.

4. The indoor unit shall have a ducted air outlet system and ducted return air system.

E. Filter:

1. Return air shall be filtered by means of a standard factory installed return air filter.

F. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.

2. The tubing shall have inner grooves for high efficiency heat exchange.

3. All tube joints shall be brazed with phos-copper or silver alloy.

4. The coils shall be pressure tested at the factory.

5. A condensate pan and drain shall be provided under the coil.

6. The unit shall be provided with an integral condensate lift mechanism able to raise drain water 21 inches above the condensate pan.

7. Both refrigerant lines to the PEFY indoor units shall be insulated in accordance with the installation manual.

G. Electrical:

1. The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.

2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

H. Controls:

1. This unit shall use controls provided by Mitsubishi Electric Cooling & Heating to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.

2. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.

3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.

4. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.

5. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

3.04 PFFY (FLOOR-STANDING-EXPOSED or FLOOR-STANDING-CONCEALED) INDOOR UNIT

A. General:

The PFFY shall consist of a floor-standing indoor section with and have a modulating linear expansion device. The PFFY shall be used with the R2-Series outdoor unit and BC Controller, Y-Series outdoor unit, or S-Series outdoor unit. The PFFY shall support individual control using M-NET DDC controllers.

B. Indoor Unit

The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

C. Unit Cabinet, Exposed:

1. The casing shall have a beige Acrylic paint finish.

D. Unit Cabinet, Recessed:

1. The casing shall have a galvanized sheet metal finish.

E. Fan:

1. The indoor unit fan shall be an assembly with one or two Sirocco fan(s) direct driven by a single motor.

2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.

3. The indoor fan shall consist of two (2) speeds, High and Low.

F. Filter:

1. Return air shall be filtered by means of an easily removable washable filter.

G. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.

2. The tubing shall have inner grooves for high efficiency heat exchange.

3. All tube joints shall be brazed with phos-copper or silver alloy.

4. The coils shall be pressure tested at the factory.

5. A condensate pan and drain shall be provided under the coil.

6. Both refrigerant lines to the PFFY indoor units shall be insulated in accordance with the installation manual.

H. Electrical:

1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.

2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

I. Controls:

1. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.

2. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.

3. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.

4. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

Part 4 – Controls

4.01 Overview

A. General:

The CITY MULTI Controls Network (CMCN) shall be capable of supporting remote controllers, centralized controllers, an integrated web based interface, graphical user workstation, and system integration to Building Management Systems via BACnet® and LonWorks®.

4.02 Electrical Characteristics

A. General:

The CMCN shall operate at 30VDC. Controller power and communications shall be via a common non-polar communications bus.

B. Wiring:

1. Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.

2. Control wiring for the Smart ME remote controller shall be from the remote controller to the first associated indoor unit (TB-5) M-NET connection. The Smart ME remote controller shall be assigned an M-NET address.

3. Control wiring for the Simple MA and Wireless MA remote controllers shall be from the remote controller (receiver) to the first associated indoor unit (TB-15) then to the remaining associated indoor units (TB-15) in a daisy chain configuration.

4. Control wiring for centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to the system controllers (centralized controllers and/or integrated web based interface), to the power supply.

5. The AE-200, AE-50, and EB-50GU centralized controller shall be capable of being networked with other AE-200, AE-50, and EB-50GU centralized controllers for centralized control.

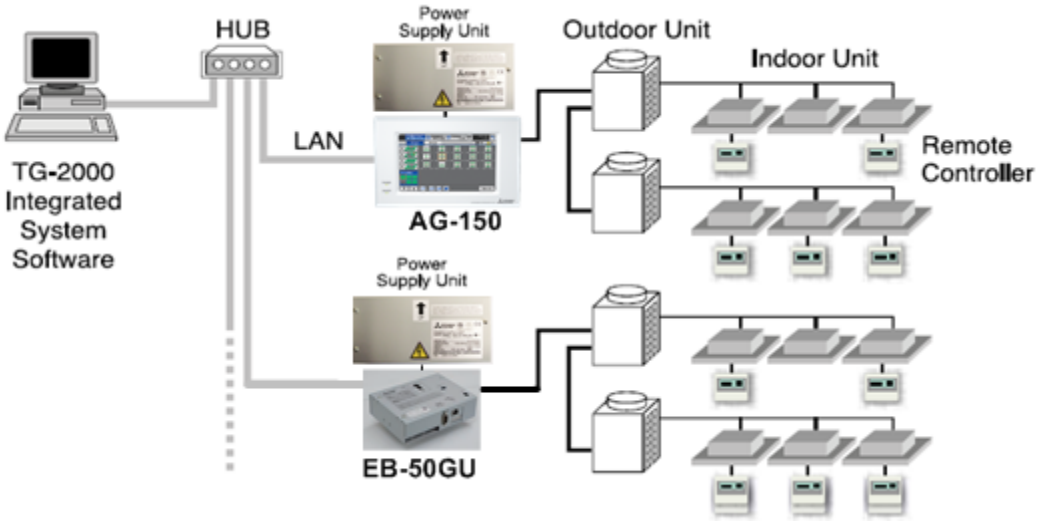
C. Wiring type:

1. Wiring shall be 2-conductor (16 AWG), twisted, stranded, shielded wire as defined by the Diamond System Builder output.

2. Network wiring shall be CAT-5 with RJ-45 connection.

4.03 CITY MULTI Controls Network

The CITY MULTI Controls Network (CMCN) consists of remote controllers, centralized controllers, and/or integrated web based interface communicating over a high-speed communication bus. The CITY MULTI Controls Network shall support operation monitoring, scheduling, occupancy, error email distribution, personal web browsers, tenant billing, online maintenance support, and integration with Building Management Systems (BMS) using either LonWorks® or BACnet® interfaces. The below figure illustrates a sample CMCN System Configuration.



CMCN System Configuration

4.04 CMCN: Remote Controllers

A. Smart ME Remote Controller (PAR-U01MEDU)

The Smart ME Remote Controller (PAR-U01MEDU) shall be capable of controlling up to 16 indoor units (defined as 1 group). The Smart ME Remote Controller shall be approximately 5.5” x 5” in size and white in color with an auto-timeout touch screen LCD display. The Smart ME Remote Controller shall support a selection from multiple languages (English, Spanish or French) for display information. The Smart ME supports temperature display selection of Fahrenheit or Celsius. The Smart ME Remote Controller shall control the following grouped operations: On/Off, Operation Mode (cool, heat, auto*, dry, fan and setback* (*R2/WR2-Series Simultaneous Heating and Cooling only)), temperature set point, fan speed setting, and airflow direction setting. The Smart ME Remote Controller shall support timer settings of on/off/temperature up to 8 times in a day in 5-minute increments. The Smart ME Remote Controller shall support an Auto Off timer. The Smart ME Remote Controller shall be able to limit the set temperature range from the Smart ME Remote Controller, or via a PC through a licensed EB-50GU. Also, the temperature range can be set from a touch screen panel on the TC-24. The room temperature shall be sensed at either the Smart ME Remote Controller or the Indoor Unit dependent on the indoor unit dipswitch setting. The Smart ME Remote Controller shall display a four-digit error code in the event of system abnormality or error.

The ME Remote Controller shall only be used in same group with other ME Remote Controllers with a maximum of two ME Remote Controllers per group.

The ME Remote Controller shall require manual addressing using rotary dial switch to the M-NET communication bus. The ME Remote Controller shall connect using two-wire, stranded, non-polar control wire to TB5 connection terminal on the indoor unit.

PAR-U01MEDU (Smart ME Remote Controller)			
Item	Description	Operation	Display
ON/OFF	Run and stop operation for a single group	Each Group	Each Group
Backlight	Turns on when screen is touched. Timeout duration is adjustable.	Each Group	Each Group

PAR-U01MEDU (Smart ME Remote Controller)			
Item	Description	Operation	Display
Operation Mode	Switches between Cool/Dry/Auto/Fan/Heat/Setback. Operation modes vary depending on the air conditioner unit. Auto and Setback mode are available for the R2/WR2-Series only.	Each Group	Each Group
Temperature Setting	Sets the temperature from 40°F – 95°F depending on operation mode and indoor unit. Separate COOL and HEAT mode set points available depending on central controller and connected mechanical equipment.	Each Group	Each Group
Fan Speed Setting	Available fan speed settings depending on indoor unit.	Each Group	Each Group
Air Flow Direction Setting	Air flow direction settings vary depending on the indoor unit model.	Each Group	Each Group
Room Temp and Humidity Display	Displays the room temperature and humidity on the Home screen. Temperature and Humidity sensed can be calibrated using the sensor offset in 1 °F or 1% RH increments.	N/A	Each Group
Occupancy Sensor	Detects occupancy using an infrared motion sensor. Occupancy status is indicated on the remote controller and through the web interface depending on connected equipment. Sensitivity is adjustable.	N/A	Each Group
Brightness Sensor	Detects brightness in the space and indicates brightness on the remote controller and through the web browser interface depending on connected equipment. Sensitivity is adjustable.	N/A	Each Group
Status Monitor	Displays the status of general equipment control points connected to the Advanced HVAC Controller (DC-A2IO)	N/A	Each Group
Humidity Setting	Sets the relative humidity set point in 1% increments for any humidifier connected to the Advanced HVAC Controller (DC-A2IO)	Each Group	Each Group
LED Indicator	Can be set to indicate the operation status by lighting and flashing with different colors and brightness or by turning off to signal operation mode, stopped unit, error, occupancy, or home screen button pushes. Color can be set to indicate the current mode selected or room temp range being sensed. *Available colors include blue, light blue, yellow, white, green, red, and lime.	Each Group	Each Group
Schedule	Set up to 8 operations per day, 7 days per week. Operations include time on/off, mode and room temperature set point.	Each Group	Each Group
Permit / Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Fan Speed, Air Direction, Reset filter). *1: Operation icon lights up on the remote controller for prohibited functions.	N/A	Each Group *1
Energy-Save control during vacancy	When vacancy is detected by the occupancy sensor 5 control options are available for selection: Stop/Setback Mode/Set Temperature Offset/Low Fan Speed/Thermo-off Brightness sensor can be used in conjunction with the occupancy sensor to increase accuracy.	Each Group	Each Group
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed	N/A	Each Unit
Test Run	Operates air conditioner units in test run mode.	Each Group	Each Group

PAR-U01MEDU (Smart ME Remote Controller)			
Item	Description	Operation	Display
Ventilation Equipment	Up to 16 indoor units can be connected to an interlocked system that has one LOSSNAY unit. LOSSNAY items that can be set are “Hi”, “Low”, and “Stop”. Ventilation mode switching is not available.	Each Group	Each Group
Set Temperature Range Limit	Set temperature range limit for auto, cool (drying) and heat modes.	Each Group	Each Group
Operation Lock Out Function	Locking of ON/OFF, Mode, Set Temp, Hold button and Air Direction.	Each Group	Each Group
Password	User and Service password protections are available	Each Group	N/A
Hold	Hold Prohibits the scheduled operation from being executed a. ON/OFF timer b. Auto-OFF timer c. Weekly timer d. Automatic return to the preset temperature * While an operation is prohibited by Hold function, the operation icon lights up.	Each Group	Each Group

4.05 Centralized Controller (Web-enabled)

A. AE-200 Centralized Controller

The AE-200A Centralized Controller shall be capable of controlling a maximum of two hundred (200) indoor units across multiple CITY MULTI outdoor units with the use of three (3) AE-50A expansion controllers. The AE-200A Centralized Controller shall be approximately 11-5/32” x 7-55/64” x 2-17/32” in size and shall be powered with an integrated 100-240 VAC power supply. The AE-200A Centralized Controller shall support system configuration, daily/weekly scheduling, monitoring of operation status, night setback settings, free contact interlock configuration and malfunction monitoring. When being used alone without the expansion controllers, the AE-200A Centralized Controller shall have five basic operation controls which can be applied to an individual indoor unit, a collection of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). This basic set of operation controls for the AE-200 Centralized Controller shall include on/off, operation mode selection (cool, heat, auto (R2/WR2-Series only), dry, setback (R2/WR2-Series only) and fan), temperature setting, fan speed setting, and airflow direction setting. Since the AE-200A provides centralized control it shall be able to enable or disable operation of local remote controllers. In terms of scheduling, the AE-200A Centralized Controller shall allow the user to define both daily and weekly schedules (up to 24 scheduled events per day) with operations consisting of ON/OFF, mode selection, temperature setting, air flow (vane) direction, fan speed, and permit/prohibit of remote controllers.

AE-200 (Centralized Controller)			
Item	Description	Operation	Display
ON/OFF	Run and stop operation.	Each Block, Group or Collective	Each Group or Collective

AE-200 (Centralized Controller)			
Item	Description	Operation	Display
Operation Mode	Switches between Cool/Dry/Auto/Fan/Heat. (Group of Lossnay unit: automatic ventilation/vent-heat/interchange/normal ventilation) Operation modes vary depending on the air conditioner unit. Auto mode is available for the R2/WR2-Series only.	Each Block, Group or Collective	Each Group
Temperature Setting	Sets the temperature from 57°F – 87°F depending on operation mode and indoor unit.	Each Block, Group or Collective	Each Group
Fan Speed Setting	Available fan speed settings depending on indoor unit.	Each Block, Group or Collective	Each Group
Air Flow Direction Setting	Air flow direction settings vary depending on the indoor unit model. *1. Louver cannot be set.	*1 Each Block, Group or Collective	Each Group
Schedule Operation	Annual/weekly/today schedule can be set for each group of air conditioning units. Optimized start setting is also available. *1. The system follows either the current day, annual schedule, or weekly, which are in the descending order of overriding priority. Twenty-four events can scheduled per day, including ON/OFF, Mode, Temperature Setting, Air Direction, Fan Speed and Operation Prohibition. Five types of weekly schedule (seasonal) can be set. Settable items depend on the functions that a given air conditioning unit supports.	*2 Each Block, Group or Collective	Each Group
Optimized Start	Unit starts 5 - 60 minutes before the scheduled time based on the operation data history in order to reach the scheduled temperature at the scheduled time.	Each Block, Group or Collective	Each Block, Group or Collective
Night Setback Setting	The function helps keep the indoor temperature in the temperature range while the units are stopped and during the time this function is effective.	Each Group	Each Group
Permit / Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter). *3. Centrally Controlled is displayed on the remote controller for prohibited functions.	Each Block, Group or Collective	*3 Each Group
Room Temp	Displays the room temperature of the group. Space temperature displayed on the indoor unit icon on the touch screen interface.	N/A	Each Group

AE-200 (Centralized Controller)			
Item	Description	Operation	Display
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed *4. When an error occurs, the LED flashes. The operation monitor screen shows the abnormal unit by flashing it. The error monitor screen shows the abnormal unit address, error code and source of detection. The error log monitor screen shows the time and date, the abnormal unit address, error code and source of detection	N/A	*4 Each Unit or Collective
Outdoor Unit Status	Compressor capacity percentage and system pressure (high and low) pressure (excludes S-Series)	Each ODU	Each ODU
Connected Unit Information	MNET addresses of all connected systems	Each IDU, ODU and BC	Each IDU, ODU and BC
Ventilation Equipment	This interlocked system settings can be performed by the master system controller. When setting the interlocked system, use the ventilation switch the free plan LOSSNAY settings between “Hi”, “Low” and “Stop”. When setting a group of only free plan LOSSNAY units, you can switch between “Normal ventilation”, “Interchange ventilation” and “Automatic ventilation”.	Each Group	Each Group
Multiple Language	Other than English, the following language can be chosen. Spanish, French, Japanese, Dutch, Italian, Russian, Chinese, and Portuguese are available.	N/A	Collective
External Input / Output	By using accessory cables you can set and monitor the following. Input By level: “Batch start/stop”, “Batch emergency stop” By pulse: “batch start/stop”, “Enable/disable remote controller” Output: “start/stop”, “error/Normal” *5. Requires the external I/O cables (PAC-YG10HA-E) sold separately.	*5 Collective	*5 Collective

All AE-200A Centralized Controllers shall be equipped with two RJ-45 Ethernet ports to support interconnection with a network PC via a closed/direct Local Area Network (LAN) or to a network switch for IP communication to up to three AE-50A expansion controllers for display of up to two hundred (200) indoor units on the main AE-200A interface.

The AE-200A Centralized Controller shall be capable of performing initial settings via the high-resolution, backlit, color touch panel on the controller or via a PC browser using the initial settings.

Standard software functions shall be available so that the building manager can securely log into each AE-200A via the PC’s web browser to support operation monitoring, scheduling, error email, interlocking and online maintenance diagnostics. Additional optional software functions of personal browser for PCs and MACs and Tenant Billing shall be available but are not included. The Tenant Billing function shall require TG-2000 Integrated System software in conjunction with the Centralized Controllers.

B. AE-50A Expansion Controller

The AE-50A Expansion Controller shall serve as a standalone centralized controller or as an expansion module to the AE-200A Centralized Controller for the purpose of adding up to 50 indoor units to either the main touch screen interface of the AE-200A. Up to three (3) AE-50A expansion controllers can be connected to the AE-200A via a local IP network (and their IP addresses assigned on the AE-200A) to the AE-200A to allow for up to two hundred .(200) indoor units to be monitored and controlled from the AE-200A interface.

The AE-50A expansion controllers have all of the same capabilities to monitor and control their associated indoor units as the features specified above. Even when connected to the AE-200A and configured to display their units on the main controller, the individual indoor units connected to the AE-50A can still be monitored and controlled from the interface of the AE-50. The last command entered will take precedence, whether at the wall controller, the AE-50A or the AE-200A Centralized Controller.

4.06 The following software functions are optional per AE-200/AE-50/EB-50GU:

1. Personal Web Browser (SW-Pweb): The CMCN shall be capable of allowing up to 50 individual users to monitor and control user defined zones via a network PC or MAC's web browser.

Tenant Billing (SW-Charge): The CMCN shall be capable of calculating CITY MULTI energy usage in kWh and in a monetary amount based on the energy consumption of the outdoor unit(s) divided among the associated indoor units per AE-200/AE-50/EB-50GU. This software is used in conjunction with the TG-2000 software a networked PC, and Watt Hour Meters (WHM).

4.07 Graphical User Workstation Software

The Graphical User Workstation Software (TG-2000) shall require a field supplied PC.

A. TG-2000 Software

The TG-2000 Integrated System Software shall enable the user to control multiple AE-200/AE-50/EB-50GU's and shall provide additional functions such as tenant billing from a single, dedicated network PC configured with the TG-2000 software. The TG-2000 configured computer shall be capable of controlling up to forty AE-200/AE-50/EB-50GU Centralized Controllers with a maximum of 2,000 indoor units across multiple CITY MULTI outdoor units. The TG-2000 software shall be required if the user wants to simultaneously control more than 1 AE-200/AE-50/EB-50GU Centralized Controllers from a single PC using a single software session. Licensing per function, per AE-200/AE-50/EB-50GU Centralized Controller shall be required for the TG-2000 software. Optional software features shall be available through the TG-2000 software including tenant billing. These optional software features shall require the TG-2000 software, advance purchase from the customer, and licensing from Mitsubishi to enable feature activation.

TG-2000 (Integrated System Software)	
Item	Details
ON/OFF	The units can turn ON and OFF for all floors or in a block, floor, or group of units.
Operation Modes	The operation mode can be switched between COOL, DRY, FAN, AUTO, and HEAT for all floors or in a block, floor, or group of units
Temperature Setting	Sets the temperature for a single group. Range of Temperature setting from 57°F – 87°F depending on operation mode and indoor unit model. Separate COOL and HEAT mode set points available depending on remote

TG-2000 (Integrated System Software)	
Item	Details
	controller and connected mechanical equipment.
Fan Speed	The fan speed can be set to four stages for all floors or in a block, floor, or group of units
Air Direction	The air direction can be set in four vertical directions or to swing for all floors or in block, floor, or group of units. (The selectable air direction differs according to the model.)
Interlocked Unit ON/OFF LOSSNAY	If there is an interlocked unit (LOSSNAY), then the unit can be turned ON (strong/weak) or OFF for all floors or in a block, floor, or group of units. (Note that the ventilation mode cannot be selected for interlocked units.)
Local Operation Prohibit	The items for which operation with the local remote controller are to be prohibited can be selected for all floors or in a block, floor, or group of units. (The items that can be prohibited are ON/OFF, operation mode, set temperature and filter sign reset.)
Annual / Weekly Schedule	The annual/weekly schedule function can be used by registering the license. Two settings, such as seasonal settings for summer and winter, can be saved.
Power Rate Apportionment Charging	A RS-485 watt-hour meter (WHM) is connected to calculate the air conditioning charges based on the amount each tenant's air-conditioner has operated. Two charging rates can be applied per day. ***OPTIONAL TENANT BILLING SOFTWARE (SW-CHARGE) REQUIRED
History	Up to 3,000 items for the error history and up to 10,000 items for operation history can be saved. Each history file can be output as a daily report or monthly report in CSV format. (The operation history consists only of the operations carried out with the TG-2000 and is limited to some limited operation items.)
Operation Time Monitor	The cumulative operation time of each indoor unit can be viewed or output as a CSV format file. (This function is valid only when the charging function license is registered.)
Filter Sign Display Mask	The filter sign display at the remote controllers can be disabled.
Set Temperature Limit	The set temperature lower limit can be set for cooling and the upper limit for heating. (ME remote controller required)

4.08 CMCN: System Integration

The CMCN shall be capable of supporting integration with Building Management Systems (BMS).

A. BAC-HD150: BACnet® Interface

4.10 The Mitsubishi Electric Cooling & Heating BACnet® interface, BAC-HD150, shall be compliant with BACnet® Protocol (ANSI/ASHRAE 135-2004) and be Certified by the (BTL) BACnet® Testing Laboratories. The BACnet® interface shall support BACnet Broadcast Management (BBMD). The BACnet® interface shall support a maximum of 50 indoor units. Operation and monitoring points include, but are not limited to, on/off, operation mode, fan speed, prohibit remote controller, filter sign reset, alarm state, error code, and error address. Power Supply (PAC-SC51KUA)

The power supply shall supply 24VDC (TB3) for the AE-200/AE-50/EB-50GU centralized controller and 30VDC (TB2) voltage for the central control transmission.

Part 6 – Execution

6.01 Installation

A. General:

Rig and install in full accordance with manufacturer's requirements, project drawings, and contract documents. Refer to the manufacturer's installation manual for full requirements.

B. Location:

Locate indoor and outdoor units as indicated on drawings. Provide service clearance per manufacturer's installation manual. Adjust and level outdoor units on support structure.

For climates that experience snowfall, mount the outdoor unit a minimum of 12" above the average snowfall line. In climates where this height requirement proves unfeasible, the outdoor units may be installed at the average snowfall line provided regular snow removal in the area surrounding the units keeps the snow line below the bottom of the units.

C. Components / Piping:

Installing contractor shall provide and install all accessories and piping for a fully operational system. Refer to manufacturer's installation manual for full instructions.

Traps, filter driers, and sight glasses are NOT to be installed on the refrigerant piping or condensate lines.

Standard ACR fittings rated for use with R410A are to be used for all connections. Proprietary manufacturer-specific appurtenances are not allowed.

Refrigerant pipe for CITY MULTI shall be made of phosphorus deoxidized copper, and has two types.

A. ACR "Annealed": Soft copper pipe, can be easily bent with human's hand.
B. ACR "Drawn Temper": Hard copper pipe (Straight pipe), being stronger than Type-O pipe of the same radical thickness.

The maximum operation pressure of R410A air conditioner is 4.30 MPa [623psi] . The refrigerant piping should ensure the safety under the maximum operation pressure. Refer to recommend piping specifications in Mitsubishi Electric's engineering manual. Pipes of radical thickness 0.7mm or less shall not be used.

Flare connection should follow dimensions provided in manufacturer's installation manuals.

D. Insulation:

Refrigerant lines, as well as any valves, shall be insulated end to end with ½" closed-cell pipe insulation for piping up to 1"in diameter, or ¾" for piping 1-1/8" and larger, with a thermal conductivity no greater than 0.27 BTU-in/hr sq.ft ^{o}F. If state or local codes require insulation other than that specified above, the greater insulation shall be used.

E. Electrical:

Installing contractor shall coordinate electrical requirements and connections for all power feeds with electrical contractor. Refer to Division 26 (Master Format 2004) or Division Section 16 (Master Format 1995) for additional information.

F. Third Party Controls:

Installing contractor shall coordinate all BAS/BMS control requirements and connections with controls contractor.

Part 7 – Service

7.01 Maintenance Tool Software and MN-Converter (CMS-MNG-E)

A. The Maintenance Tool, via the MN-Converter (CMS-MNG-E), shall enable the user to monitor and record the following parameters in a centralized system.

i. Outdoor Unit

1. Operation Mode (Cooling Only, Heating Only, Cooling Main, Heating Main)
2. Compressor Frequency, amperages, and voltages
3. Compressor high- and low-side pressure
4. System Temperatures
5. Outdoor temperature
6. Status of reversing valve

ii. BC Controller

1. Valve ON/OFF status
2. Temperatures
3. Pressures

iii. Indoor Unit

1. Entering Air Temperature
2. Entering/Leaving Refrigerant Temperature
3. Superheat/Subcool temperatures
4. LEV position
5. Room temperature setpoint
6. Unit Mode and Status (Heat, Cool, Dry, Auto, Fan)

B. The Maintenance Tool shall have the additional feature of controlling the following system components manually:

i. Indoor Unit

1. Indoor Unit ON/OFF
2. Mode (Heat, Cool, Dry, Auto, Fan)
3. Room Temperature Setpoint
4. Fan speed
5. LEV Position

ii. BC Controller

1. Valve OPEN/CLOSE
2. LEV Position

C. The Maintenance Tool shall be connectable to either the TB3 or TB7 communication bus lines on the MNET via alligator connectors.

D. The Maintenance Tool shall be connectable to a PC via a USB cable.

E. Trended data from Maintenance Tool shall be available to export to a data file for offline analysis.

END OF SECTION 238126

SECTION 238239 - 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:
   1. Propeller unit heaters with electric coils.
   2. Electric unit heaters wall mounted.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CWP: Cold working pressure.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.

B. LEED Submittal:

   1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1-2004, Section 5 - "Systems and Equipment."

C. 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. Plans, elevations, sections, and details.
   2. Location and size of each field connection.
   3. Details of anchorages and attachments to structure and to supported equipment.
   4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
   5. Location and arrangement of piping valves and specialties.
   6. Location and arrangement of integral controls.
   7. Wiring Diagrams: Power, signal, and control wiring.

D. Coordination Drawings: Floor plans, reflected ceiling 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. Suspended ceiling components.
2. Structural members to which unit heaters will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.

6. Perimeter moldings for exposed or partially exposed cabinets.

E. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.

F. Samples for Verification: Finish colors for each type of cabinet unit heater and wall and ceiling heaters indicated with factory-applied color finishes.

G. Manufacturer Seismic Qualification Certification: Submit certification that cabinet unit heaters, accessories, and components will withstand seismic forces defined in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

H. Field quality-control test reports.

I. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cabinet Unit Heater Filters: Furnish one spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 PROPELLER UNIT HEATERS

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

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

1. Airtherm; a Mestek Company.
2. Engineered Air Ltd.
3. McQuay International.
4. Rosemex Products.
5. Ruffneck Heaters; a division of Lexa Corporation.
6. Trane.
7. Marley Engineering Products.

C. Description: An assembly including casing, coil, fan, and motor in vertical discharge configuration with adjustable discharge louvers.

D. Comply with UL 2021.

E. Comply with UL 823.

F. Cabinet: Removable panels for maintenance access to controls.

G. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.

H. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

I. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

J. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high temperature protection.

K. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

L. Fan Motors: Comply with requirements in Division 15 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Type: Permanently lubricated,.

M. Control Devices:

1. Unit-mounted fan-speed switch.
2. Unit-mounted thermostat.

N. Capacities and Characteristics: See schedule on drawings.

2.2 WALL AND CEILING HEATERS

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

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Berko Electric Heating; a division of Marley Engineered Products.
2. Chromalox, Inc.; a division of Emerson Electric Company.
3. Indeeco.
4. Markel Products; a division of TPI Corporation.
5. Marley Electric Heating; a division of Marley Engineered Products.
6. Ouellet Canada Inc.
7. QMark Electric Heating; a division of Marley Engineered Products.
8. Trane.

D. Description: An assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

E. Cabinet:

1. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.
2. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

F. Surface-Mounting Cabinet Enclosure: Steel with finish to match cabinet.

G. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high temperature protection.

H. Fan: Aluminum propeller directly connected to motor.

1. Motor: Permanently lubricated. Comply with requirements in Division 15 Section "Common Motor Requirements for HVAC Equipment."

I. Controls: Unit-mounted thermostat.

J. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

K. Capacities and Characteristics: See schedule on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and 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 wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Division 07 Section "Joint Sealants."

B. Install cabinet unit heaters to comply with NFPA 90A.

C. Install propeller unit heaters level and plumb.

D. Suspend cabinet unit heaters from structure with elastomeric hangers. Vibration isolators are specified in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

E. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers. Hanger rods and attachments to structure are specified in Division 15 Section "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

F. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

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 machine to allow service and maintenance.

C. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

D. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors.

E. Comply with safety requirements in UL 1995.

F. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of unit heater. Hydronic specialties are specified in other sections.

G. Unless otherwise indicated, install union and gate or ball valve on steam-supply connection and union, strainer, steam trap, and gate or ball valve on condensate-return connection of unit heater. Steam specialties are specified in other sections

H. Ground equipment according to Section "Grounding and Bonding for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspectfield-assembled components and equipment installation, including connections. 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 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.

C. Remove and replace malfunctioning units and retest as specified above.

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.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Division 01 Section "Demonstration and Training.

END OF SECTION 238239

SECTION 260400 - CODES AND FEES

PART 1 GENERAL

1.1 DESCRIPTION

A. General: Comply with Codes in accordance with the Contract Documents.

1.2 CODES

A. The electrical installation shall be in compliance with the requirements of O.S.H.A., N.E.C., Local Codes and the rules, regulations and requirements of the power company supplying power to the building.

B. The electrical installation shall comply fully with all county and state laws, ordinances and regulations applicable to electrical installations.

C. All equipment shall be equal to or exceed the minimum requirements of N.E.M.A., I.E.E.E. and U.L.

1.3 FEES

A. All local fees and permits and services of inspection authorizes shall be obtained and paid for by the Contractor. Contractor shall pay for all subcontracted services.

1.4 CERTIFICATE OF INSPECTION

A. Certificate of Inspection and approval shall be procured and paid for by this Contractor for an independent electrical inspection and delivered to the Owner before final payment is made.

END OF SECTION 260400

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

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. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Grout.
5. Common electrical installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For sleeve seals.

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."."

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Available Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

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

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants.".

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. 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.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use 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.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 260500

SECTION 260519 - BUILDING WIRE AND CABLE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Building wire and cable.
   2. Wiring connectors and connections.

B. RELATED SECTIONS
   1. Section 260553 – Electrical Identification.
   2. Section 260533 – Raceway and Boxes.

1.2 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data: Provide for each cable assembly type.

C. Test Reports: Indicate procedures and values obtained.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section.

1.5 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc.

1.6 FIELD SAMPLES

A. Reserved

1.7 PROJECT CONDITIONS

A. All conductors shall be copper.

B. Route wire and cable parallel to building’s structural elements and as necessary to meet Project Conditions.

C. Determine exact routing and lengths required.

1.8 COORDINATION

A. Coordinate Work under provisions of Division 1.

B. Determine required separation between cable and other work.

C. Determine cable routing to avoid interference with other work.

PART 2 PRODUCTS

2.1 MANUFACTURERS - BUILDING WIRE AND CABLE

A. American Insulated Wire Corporation.

B. Carol Cable Company.

C. Rome Cable.

2.2 BUILDING WIRE AND CABLE

A. Description: Stranded insulated wire.

B. Conductor: Copper.

C. Insulation Voltage Rating: 600 volts.

D. Insulation: ANSI/NFPA 70, Type THHN/THWN.

2.3 NON-METALLIC SHEATHED CABLE

A. Description: Stranded insulated wire.

B. Conductor: Copper.

C. Insulation Voltage Rating: 600 volts.

D. Insulation: ANSI/NFPA 70, Type NM

2.4 METAL CLAD CABLE

A. Description: ANSI/NFPA 70, Type MC.

B. Conductor: Copper.

C. Insulation Voltage Rating: 600 volts.

D. Insulation Temperature Rating: 90 degrees C.

E. Insulation Material: Thermoplastic, THHN/THWN.

F. Armor Material: Steel or Aluminum.

G. Armor Design: Interlocked metal tape.

H. Jacket: PVC in locations specified in Article 3.03 WIRING METHODS.

2.5 WIRING CONNECTORS

A. Split Bolt Connectors:
1. Burndy Corporation.
2. Ilsco.
3. Teledyne Penn Union.
4. Substitutions: Under provisions of Division 1.

B. Solderless Pressure Connectors:
1. Burndy Corporation.
2. Ilsco.
3. Teledyne Penn Union.
4. Substitutions: Under provisions of Division 1.

C. Spring Wire Connectors:
1. 3M.
2. Buchanan.
3. Burndy.
4. Substitutions: Under provisions of Division 1

D. Compression Connectors:
1. Burndy Corporation.
2. Ilsco.
3. Teledyne Penn Union.
4. Substitutions: Under provisions of Division 1.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that mechanical work likely to damage wire and cable has been completed.

3.2 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.3 WIRE COLOR

A. General
1. For wire sizes 10 AWG and smaller, install wire colors in accordance with the following:
a. Black (Phase A), red (Phase B), and blue (Phase C) for circuits at 120/208 volts single or three phase.
b. Brown (Phase A), orange (Phase B), and yellow (Phase C) for circuits at 277/480 volts single or three phase.
2. For wire sizes 8 AWG and larger, identify wire with colored tape at terminals, splices and boxes. Colors are as follows:
a. Black (Phase A), red (Phase B), and blue (Phase C) for circuits at 120/208 volts single or three phase.

b. Brown (Phase A), orange (Phase B), and yellow (Phase C) for circuits at 277/480 volts single or three phase.

3. For ground wire shall be green.
4. For neutral wire shall be white for 120/208 and grey for 277/480 volts.

3.4 WIRING METHODS

A. Concealed Dry Interior Locations above lay-in ceilings or non block partition walls: Use THHN/THWN insulation, in raceway for home runs. MC cable may be used for branch circuit wiring other than homeruns.

B. Exposed Dry Interior Locations: Use building wire THHN/THWN insulation in rigid galvanized steel raceway.

C. Above Accessible Ceilings: Use building wire THHN/THWN insulation in raceway for homeruns. Use metal clad cable for branch circuit wiring other than home runs.

D. Wet or Damp Interior Locations: Use only building wire Type THHN/THWN insulation in rigid galvanized steel raceway.

E. Exterior Locations: Use building wire THHN/THWN insulation in RGS raceway.

3.5 INSTALLATION

A. Install products in accordance with manufacturers instructions.

B. Use stranded conductors for all feeders and branch circuits.

C. Use stranded conductors for control circuits.

D. Use conductor not smaller than 12 AWG for power and lighting circuits.

E. Use conductor not smaller than 14 AWG for control circuits.

F. Use one size larger conductors for runs longer than 100 feet.

G. Pull all conductors into raceway at same time.

H. Use suitable wire pulling lubricant for building wire 4 AWG and larger.

I. Protect exposed cable from damage.

J. Support cables above accessible ceiling, using spring metal clips to support cables from structure. Do not rest cable on ceiling panels.

K. Use suitable cable fittings and connectors.

L. Neatly install wiring inside boxes, equipment, and panelboards.

M. Clean conductor surfaces before installing lugs and connectors.

N. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

O. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.

P. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

Q. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

R. Install wiring concealed in finished spaces. Provide any required fishing and patching where required. Wiring in finished spaces with concrete block walls shall be wired with wiring concealed in the block wall cavity and all devices and fixture boxes set flush with concrete block surfaces. Interior Concealed wiring in block walls shall be schedule 40 PVC or rigid metal raceway. Do not mount boxes or devices in block joints.

3.6 INTERFACE WITH OTHER PRODUCTS

A. Identify wire and cable under provisions of Section 260553.

B. Identify each conductor with its circuit number or other designation indicated on Drawings.

3.7 FIELD QUALITY CONTROL

A. Inspect wire and cable for physical damage and proper connection.

B. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.

C. Verify continuity of each branch circuit conductor.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Grounding electrodes and conductors.
2. Equipment grounding conductors.
3. Bonding.

1.2 RELATED SECTIONS

A. Reserved.

1.3 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

1.4 GROUNDING ELECTRODE SYSTEM (As applicable)

A. Metal underground water pipe.

B. Rod electrode.

1.5 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: Maximum of 5 ohms.

1.6 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data: Provide data for grounding electrodes and connections.

C. Test Reports: Indicate overall resistance to ground and resistance of each electrode.

D. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation and installation of exothermic connectors.

1.7 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of grounding electrodes.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this Section.

1.9 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc.

PART 2 PRODUCTS

2.1 ROD ELECTRODE

A. Manufacturers:
1. American Electric.
2. Blackburn, Thomas & Betts.
3. Substitutions: Under provisions of Division 1.

B. Material: Copper

C. Diameter: 5/8 inch.

D. Length: 10 feet.

2.2 MECHANICAL CONNECTORS

A. Manufacturers:
1. Ilsco Model AGC.
2. Equal by Burndy.
3. Equal by Teledyne Penn Union.
4. Substitutions: Under provisions of Division 1.

B. Material: Bronze.

2.3 EXOTHERMIC CONNECTIONS

A. Manufacturers:
1. ERICO Products, Inc. (Cadweld).

2.4 WIRE

A. Material: Stranded copper.

B. Grounding Electrode Conductor: Size as shown on the drawings, if not shown, conductor shall be as required by the local jurisdiction and the utility company.

2.5 GROUNDING WELL COMPONENTS

A. Test Well Pipe: 12 inch diameter by 24 inch long clay tile or concrete pipe with belled end.

B. Well Cover: Cast iron with legend "GROUND" embossed on cover.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 INSTALLATION

A. Install Products in accordance with manufacturer's instructions.

B. Install additional rod electrodes as required to achieve the NEC minimum, or the specified resistance to ground.

C. Provide grounding well pipe with cover at rod locations. Install well pipe top flush with finished grade.

D. Provide bonding to meet Regulatory Requirements.

E. Provide isolated grounding conductor for circuits supplying IG receptacles.

F. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Reserved.

3.4 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Use suitable test instrument to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.

END OF SECTION 260526

SECTION 260529 - ELECTRICAL HANGERS AND SUPPORTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Conduit and equipment supports.
   2. Anchors and fasteners.

B. REFERENCES
   1. NECA - National Electrical Contractors Association.
   2. ANSI/NFPA 70 - National Electrical Code.

1.2 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data: Provide manufacturer's catalog data for fastening systems.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.3 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc.

PART 2 PRODUCTS

2.1 PRODUCT REQUIREMENTS

A. Materials and Finishes: Provide adequate corrosion resistance. All fasteners exposed to a corrosive environment or installed outside shall be stainless steel.

B. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.

C. Anchors and Fasteners:
   1. Concrete Structural Elements: Use expansion anchors and preset inserts.
   2. Steel Structural Elements: Use beam clamps, spring steel clips and welded fasteners.
   3. Concrete Surfaces: Use expansion anchors.
   4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts and hollow wall fasteners.
   5. Solid Masonry Walls: Use expansion anchors.
   6. Sheet Metal: Use sheet metal screws.
   7. Wood Elements: Use wood screws.

2.2 STEEL CHANNEL

A. Manufacturer:
   1. Unistrut Model P1000.
   2. Substitutions: Under provisions of Division 1.

B. Description: Painted steel.

2.3 SPRING STEEL CLIPS

A. Manufacturer:
   1. B-line.
   2. Caddy.
   3. Substitutions: Under provisions of Division 1.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".

C. Do not fasten supports to pipes, ducts, mechanical equipment, suspended ceiling wires and conduit.

D. Do not use spring steel clips and clamps except on concealed metal studs.

E. Do not use powder-actuated anchors.

F. Obtain permission from Architect/Engineer before drilling or cutting structural members.

G. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

H. Install surface-mounted cabinets and panelboards with minimum of four anchors.

I. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch (25 mm) off of wall.

J. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

K. Support fixtures independently of ceilings.

END OF SECTION 260529

SECTION 260533 - RACEWAY 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. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:

1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. EPDM: Ethylene-propylene-diene terpolymer rubber.

D. FMC: Flexible metal conduit.

E. IMC: Intermediate metal conduit.

F. LFMC: Liquidtight flexible metal conduit.

G. LFNC: Liquidtight flexible nonmetallic conduit.

H. NBR: Acrylonitrile-butadiene rubber.

I. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. Custom enclosures and cabinets.
2. For handholes and boxes for underground wiring, including the following:

a. Duct entry provisions, including locations and duct sizes.
b. Frame and cover design.
c. Grounding details.
d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
e. Joint details.

C. Samples for Initial Selection: For surface raceways with factory-applied texture and color finishes.

D. Samples for Verification: For each type of exposed finish required for surface raceways, prepared on Samples of size indicated below.

E. Coordination Drawings: Conduit routing 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 in the paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

F. Manufacturer Seismic Qualification Certification: Submit certification that enclosures and cabinets and their mounting provisions, including those for internal components, will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the cabinet or enclosure will remain in place without separation of any parts when subjected to the seismic forces specified."

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.

G. Qualification Data: For professional engineer and testing agency.

H. Source quality-control test reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

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

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

1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
6. Manhattan/CDT/Cole-Flex.
7. Maverick Tube Corporation.
8. O-Z Gedney; a unit of General Signal.
9. Wheatland Tube Company.

C. Rigid Steel Conduit: ANSI C80.1.

D. Aluminum Rigid Conduit: ANSI C80.5.

E. IMC: ANSI C80.6.

F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: T0.040 inchTT (1 mm)T, minimum.

G. EMT: ANSI C80.3.

H. FMC: Zinc-coated steel or aluminum.

I. LFMC: Flexible steel conduit with PVC jacket.

J. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
2. Fittings for EMT: Steel or die-cast, compression type.
3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, T0.040 inchTT (1 mm)T, with overlapping sleeves protecting threaded joints.

K. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

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

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

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corporation.
4. CANTEX Inc.

5. CertainTeed Corp.; Pipe & Plastics Group.
6. Condux International, Inc.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT/Cole-Flex.
11. RACO; a Hubbell Company.
12. Thomas & Betts Corporation.

C. ENT: NEMA TC 13.

D. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

E. LFNC: UL 1660.

F. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

G. Fittings for LFNC: UL 514B.

2.3 METAL WIREWAYS

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

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

1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

C. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

D. Fittings and Accessories: Include 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.

E. Wireway Covers: Screw-cover type.

F. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.

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

a. Thomas & Betts Corporation.

b. Walker Systems, Inc.; Wiremold Company (The).
c. Wiremold Company (The); Electrical Sales Division.

2.5 BOXES, ENCLOSURES, AND CABINETS

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

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

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

C. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

D. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

E. Metal Floor Boxes: Cast metal, fully adjustable, rectangular.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

H. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic.

I. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.6 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum T0.052- or 0.138-inchTT (1.3- or 3.5-mm)T thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.7 SLEEVE SEALS

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

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

D. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.8 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by a independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit.
2. Concealed Conduit, Aboveground: Rigid steel conduit.
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
6. Application of Handholes and Boxes for Underground Wiring:

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT or Wiremold (as noted on drawings).
2. Exposed, Not Subject to Severe Physical Damage: EMT or Wiremold (as noted on drawings).
3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:

    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT for homeruns and MC Cable may be utilized
5. Damp or Wet Locations: Rigid steel conduit.

C. Minimum Raceway Size: T3/4-inchTT (21-mm)T 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.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

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 in contact with concrete.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least T6 inchesTT (150 mm)T away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Raceways Embedded in Slabs:

1. Run conduit larger than T1-inchTT (27-mm)T trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Change from ENT to RNC, Type EPC-40-PVC, rigid steel conduit, or IMC before rising above the floor.

I. 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.

J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than T200-lbTT (90-kg)T tensile strength. Leave at least T12 inchesTT (300 mm)T of slack at each end of pull wire.

L. Install raceway sealing fittings at suitable, approved, and accessible locations 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 at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

M. Flexible Conduit Connections: Use maximum of T72 inchesTT (1830 mm)T of flexible conduit for recessed and semirecessed lighting fixtures, 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.

N. 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.

O. Set metal floor boxes level and flush with finished floor surface.

P. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than T6 inchesTT (150 mm)T in nominal diameter.
2. Install backfill as specified in Division 31 Section "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within T12 inchesTT (300 mm)T of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with T3 inchesTT (75 mm)T of concrete.
    b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of T60 inchesTT (1500 mm)T from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately T12 inchesTT (300 mm)T above direct-buried conduits, placing them T24 inchesTT (600 mm)T o.c. Align planks along the width and along the centerline of conduit.

3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve cross-section rectangle perimeter less than T50 inchesTT (1270 mm)T and no side greater than T16 inchesTT (400 mm)T, thickness shall be T0.052 inchTT (1.3 mm)T.
2. For sleeve cross-section rectangle perimeter equal to, or greater than, T50 inchesTT (1270 mm)T and 1 or more sides equal to, or greater than, T16 inchesTT (400 mm)T, thickness shall be T0.138 inchTT (3.5 mm)T.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both surfaces of walls.

G. Extend sleeves installed in floors T2 inchesTT (50 mm)T above finished floor level.

H. Size pipe sleeves to provide T1/4-inchTT (6.4-mm)T annular clear space between sleeve and raceway unless sleeve seal is to be installed.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for T1-inchTT (25-mm)T annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for T1-inchTT (25-mm)T annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.5 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.7 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260553 - ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Nameplates.
   2. Labels.
   3. Wire markers.
   4. Conduit markers.
   5. Stencils.

1.2 SUBMITTALS

A. Division 1 - Submittal Procedures: Submittal procedures.

B. Product Data:
   1. Submit manufacturer’s catalog literature for each product required.
   2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.

C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.3 CLOSEOUT SUBMITTALS

A. Division 1 - Execution Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of tagged devices; include tag numbers.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Division 1 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept identification products on site in original containers. Inspect for damage.

C. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

D. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Division 1 - Product Requirements: Environmental conditions affecting products on site.

1.7 EXTRA MATERIALS

A. Division 1 - Execution Requirements: Requirements for extra materials.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:
   1. Seton.
   2. Brady.
   3. Substitutions: Division 1 - Product Requirements.

B. Product Description: Laminated three-layer plastic with black engraved letters on contrasting white background color.

C. Letter Size:
   1. 1/8 inch high letters for identifying individual equipment and loads.
   2. 1/4 inch high letters for identifying grouped equipment and loads.

D. Minimum nameplate thickness: 1/8 inch.

2.2 LABELS

A. Manufacturers:
   1. Seton.
   2. Brady.
   3. Substitutions: Division 1 - Product Requirements.

B. Labels: Embossed adhesive tape, with 3/16 inch black letters on white background.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces for stencil painting.

3.2 INSTALLATION

A. Install identifying devices after completion of painting.

B. Nameplate Installation:
   1. Install nameplate parallel to equipment lines.
   2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners, or adhesive.
   3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners, or adhesive.
   4. Secure nameplate to equipment front using adhesive.

5. Secure nameplate to inside surface of door on recessed panelboard in finished locations.
6. Install nameplates for the following:
    a. Switchboards.
    b. Service Disconnects.

C. Label Installation:
1. Install label parallel to equipment lines.
2. Install label for identification of individual control device stations, and
3. Install labels for permanent adhesion and seal with clear lacquer.

END OF SECTION 260553

SECTION 260943 – Network Lighting Controls Acuity Brands-Light Network Controls

PART 1 – GENERAL

1.0 SECTION INCLUDES

A. Network lighting control system and components:
   1. Touch panel controls
   2. Lighting management panels
   3. Lighting management modules
   4. Low voltage wall stations
   5. Power interfaces
   6. Wired sensors

1.1. RELATED DOCUMENTS

A. Section 262726 Wiring Devices
B. Section 260943.13 Digital-Network Lighting Controls
C. Section 260943.16 Addressable Fixture Lighting Control
D. Section 260943.19 Wireless Network Lighting Controls
E. Section 265100 Interior Lighting Fixtures

1.2. SUMMARY

A. The lighting control system specified in this section shall provide time-based, sensor-based (both occupancy and daylight), and manual lighting control
B. The system shall be capable of turning lighting loads on/off as well as dimming lights (if lighting load is capable of being dimmed). Specific dimmers will be capable of “dimming lights to off”
C. All system devices shall be networked together, enabling digital communication between devices, and shall be individually addressed.
D. The system architecture shall be capable of enabling stand-alone groups (rooms) of devices to function in some default capacity, even if network connectivity to the greater system is lost.
E. The system architecture shall facilitate remote operation via a computer connection.
F. The system shall not require any centrally hardwired switching equipment.
G. The system shall be capable of wireless, wired, or hybrid wireless/wired architectures.

1.3 SUBMITTALS

A. Product Datasheets (general device descriptions, dimensions, electrical specifications, wiring details, nomenclature)
B. Riser Diagrams – typical per room type (detailed drawings showing device interconnectivity of devices)
C. Other Diagrams – as needed for special operation or interaction with other system(s)
D. Example Contractor Startup/Commissioning Worksheet – must be completed prior to factory start-up
E. Hardware and Software Operation Manuals
F. Other operational descriptions as needed

1.4 PROJECT CLOSEOUT DOCUMENTATION

A. Provide a factory published manual
   1. Warranty
   2. Technical support contact
   3. Electronic manual on manufacturer’s website for free download

1.5 QUALITY ASSURANCE

A. All steps in sensor manufacturing process shall occur in North America; including population of all electronic components on circuit boards, soldering, programming, wiring, and housing.
B. All components and the manufacturing facility where product was manufactured must be RoHS compliant.
C. In high humidity or cold environments, the sensors shall be conformably coated and rated for condensing humidity and -40 degree Fahrenheit (and Celsius) operation.

D. All applicable products must be UL / CUL Listed or other acceptable national testing organization.

1.6 PROJECT CONDITIONS

A. Only install equipment after the following site conditions are maintained:
    1. Ambient Temperature 14 to 105 degrees F (-10 to 40 degrees C)
    2. Relative Humidity less than 90% non-condensing
B. Standard electrical enclosures are permanently installed
C. Equipment is protected from dust, debris and moisture

1.7 WARRANTY

A. Five (5) year 100% parts replacement

1.8 MAINTENANCE & SUSTAINABILITY

A. Provide new parts, upgrades, and/or replacements available for a minimum of 5 years available to the end user
B. Provide free telephone technical support

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Acuity Brands Lighting, Inc. – System: nLight by Acuity Controls
B. Basis of controls design Manufacturer: Acuity Brands, One Lithonia Way, Conyers GA 30012, www.acuitycontrols.com
C. Substitutions: Permitted {Under Division 1}:
    1. All substitutions must be an equal, no additional monies will be permitted to make equal.
    2. Proposed substitute products must be documented with a line by line compliance review

2.2 SYSTEM REQUIREMENTS

A. System shall have an architecture that is based upon three main concepts; 1) intelligent lighting control devices 2) standalone lighting control zones 3) network backbone for remote or time based operation.
B. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.
C. System must interface directly with intelligent LED luminaires such that only CAT-5 cabling is required to interconnect luminaires with control components such as sensors and switches (see *Networked LED Luminaire* section).
D. Intelligent lighting control devices shall communicate digitally, require <7 mA of current to function (Graphic wall stations excluded), and possess RJ-45 style connectors.
E. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher level network backbone.
F. Devices within a lighting control zone shall be connected with CAT-5e low voltage cabling in any order.
G. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.
H. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.
I. Power for devices within a lighting control zone shall come from either resident devices already present for switching (relay device) or dimming purposes, controls enabled luminaires, or from the network backbone. Standalone “bus power supplies” shall not be required in all cases.

J. All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e. not in remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.
K. System shall have one or more primary wall mounted network control “gateway” devices that are capable of accessing and controlling connected system devices and linking into an Ethernet LAN.
L. System shall use “bridge” devices that route communication and distribute power for up to 8 directly connected lighting zones together for purposes of decreasing system wiring requirements.
M. System shall be capable of wirelessly connecting a lighting zone to a WiFi (802.11n) wireless data network for purposes of eliminating the “bridge” devices and all cabling that connects zones to bridge devices.
N. WiFi enabled devices shall be able to detect when WiFi network is down and revert to a user directed default state.
O. WiFi-enabled devices shall be capable of current monitoring
P. WiFi-enabled devices shall utilize WPA2 AES encryption
Q. WiFi-enabled devices shall be able to connect to 802.11b/g/n WiFi networks
R. WiFi-enabled devices shall have two local RJ-45 port for communicating with non WiFi-enabled system devices
S. System shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control schedules and profiles.
T. Individual lighting zones shall be capable of being segmented into several “local” channels of occupancy, photocell, and switch functionality for more advanced configurations and sequences of operation.
U. Devices located in different lighting zones shall be able to communicate occupancy, photocell (non-dimming), and switch information via either the wired or WiFi backbone.
V. System shall be capable of operating a lighting control zone according to several sequences of operation. System shall be able to change a spaces sequence of operation according to a time schedule so as to enable customized time-of-day, day-of-week, utilization of a space. Note: Operating modes should be utilized only in manners consistent with local energy codes.
    1. Auto-On / Auto-Off (via occupancy sensors)
        • Zones with occupancy sensors automatically turn lights on when occupant is detected.
        • Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
        • Pressing a switch will turn lights off. The lights will remain off regardless of occupancy until switch is pressed again, restoring the sensor to Automatic On functionality.
    2. Manual-On / Auto-Off (also called Semi-Automatic)
        • Pushing a switch will turn lights on.
        • Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
    3. Manual-On to Auto-On/Auto-Off
        • Pushing a switch will turn lights on.
        • After initial lights on, zones with occupancy and/or photocell sensors turn lights on/off according to occupancy/vacancy and/or daylight conditions.
        • Sequence can be reset via scheduled (ex. daily each morning) events.
    4. Auto-to-Override On
        • Zones with occupancy sensors automatically turn lights on when occupant is detected.
        • Zone lighting then goes into an override on state for a set amount of time, or until the next time event returns the lighting to an auto-off style of control.
        • Sequence can be reset via scheduled (ex. daily each morning) events.
    5. Manual-to-Override On
        • Pushing a switch will turn lights on.
        • Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.
        • Sequence can be reset via scheduled (ex. daily each morning) events.

6. Auto On / Predictive Off
   - Zones with occupancy sensors automatically turn lights on when occupant is detected.
   - Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
   - Pressing the switch will turn the lights off and a short “exit timer” begins. After the timer expires, sensor scans the room to detect whether occupant is still present. If no occupancy is detected, zone returns to auto-on. If occupancy is detected, lights must be turned on via the switch.
7. Multi-Level Operation (multiple lighting levels per manual button press)
   - Operating mode designed specifically for bi-level applications.
   - Enables the user to cycle through up to four potential on/off/dim low/dim high lighting states using only a single button.
   - Eliminates user confusion as to which of two buttons controls which load
   - Three different transition sequences are available in order to comply with energy codes or user preference).
   - Mode available as a setting on all devices that have single manual on/off switch (ex. nPODM, nPODM-DX, nWSX LV).
   - Depending on the sequence selected, every button push steps through relay/dimming states according to below table
   - In addition to achieving bi-level lighting control by switching loads with relays, the ability to command dimming outputs to “step” in a sequence that achieves bi-level operation is present.

		State of load after each pushbutton press			
MLO Mode		1st Press	2nd Press	3rd Press	4th Press
2-State (Alternating)	Load A	On	Off	Off	-
	Load B	Off	On	Off	-
2-State (Both On, A First)	Load A	On	On	Off	-
	Load B	Off	On	Off	-
2-State (Both On, B First)	Load A	Off	On	Off	-
	Load B	On	On	Off	-
3-State	Load A	On	Off	On	Off
	Load B	Off	On	On	Off
A and B On [1]	Load A	On	Off	-	-
	Load B	On	Off	-	-
A On Only [1]	Load A	On	Off	-	-
	Load B	Off	Off	-	-
A and B On & Dim High [1]	Load A	High	Off	-	-
	Load B	High	Off	-	-
Dim Low /High	Load A	Low	High	Off	-
Dim Low / High	Load A	High	Low	Off	-

NOTE 1: Modes for use only when Auto-On state of Load A & B is different than first MLO state

W. A taskbar style desktop application shall be available for personal lighting control.
X. An application that runs on “smart” handheld devices (such as an Apple® IPhone®) shall be available for personal lighting control.
Y. Control software shall enable logging of system performance data and presenting thisl information in a web-based format and downloadable to .CSV files.
Z. Control software shall enable integration with a BMS via BACnet IP, although a hardware BACnet IP integration solution is also available.

AA. System shall provide the option of having pre-terminated plenum rated CAT-5e cabling supplied with hardware.

2.3 INDIVIDUAL DEVICE SPECIFICATIONS

A. Control module (gateway)

1. Control module shall be a device that facilitates communication and time-based control of downstream network devices and linking into an Ethernet network.
2. Devices shall have a user interface that is capable of wall mounting, powered by low voltage, and have a touch screen.
3. Control device shall have three RJ-45 ports for connection to the graphic touch screen, other backbone devices bridges) or directly to lighting control devices(up to 128 per port).
4. Device shall automatically detect all devices downstream of it.
5. Device shall have a standard and astronomical internal time clock.
6. Device shall have one RJ-45 10/100 BaseT Ethernet connection.
7. Device shall have a USB port
8. Each control gateway device shall be capable of linking 1500 devices to the management software, with reduced memory version capable of support up to 400 devices.
9. Device shall be capable of using a dedicated static or DHCP assigned IP address.
10. Network Control Gateway device shall be the following nLight model Series: nGWY2

B. Networked system occupancy sensors

1. Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
2. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
3. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional “dual” technology shall be used.
4. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable.
5. All sensing technologies shall be acoustically passive, meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.
6. Sensors shall be available with zero or one integrated dry contact switching relays, capable of switching 1 amp at 24 VAC/VDC (resistive only).
7. Sensors shall be available with one or two occupancy “poles”, each of which provides a programmable time delay.
8. Sensors shall be available in multiple lens options which are customized for specific applications.
9. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
10. All sensors shall have two RJ-45 ports or capable of utilizing a splitter.
11. All sensors shall have the ability to detect when it is not receiving valid communication (via CAT-5 connections) and blink its LED in a pattern to visually indicate of a potential wiring issue

12. Every sensor parameter shall be available and configurable remotely from the software and locally via the device push-button.
13. Sensors shall be able to function together with other sensors in order to provide expanded coverage areas by simply daisy-chain wiring together the units with CAT-5 cabling.
14. Sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements.
15. Wall switch sensors shall recess into single-gang switch box and fit a standard GFI opening.
16. Wall switch sensors must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load wire connections shall be interchangeable. Sensor shall not allow current to pass to the load when sensor is in the unoccupied (Off) condition.
17. Wall switch sensors shall have optional features for photocell/daylight override, and low temperature/high humidity operation.
18. Wall switch sensors shall be available in four standard colors (Ivory, White, Light Almond, Gray)
19. Wall switch sensors shall be available with optional raise/lower dimming adjustment controls.
20. Wall switch sensors shall be the following nLight model numbers, with device color and optional features as specified:
    nWSX (PIR, 1 Relay)
    nWSX PDT (Dual Tech, 1 Relay)
    nWSX LV (PIR, No Relay)
    nWSX PDT LV (Dual Tech, No Relay)
    nWSX LV NL (PIR w/ Night Light, No Relay)
    nWSX PDT LV NL (Dual Tech w/ Night Light, No Relay)
    nWSX LV DX (PIR, No Relay, Raise/Lower Dim Ctrl)
    nWSX PDT LV DX (Dual Tech, No Relay,Raise/Lower Dim Ctrl)

21. Network system shall have sensors that can be embedded into luminaire such that only the lens shows on luminaire face.
22. Embedded sensors shall be capable of both PIR and Dual Technology occupancy detection
23. Embedded sensors shall have an optional photocell
24. Embedded sensors shall be the following nLight model number:
    nES 7 (PIR, No Relay)
    nES 7 ADCX (PIR w/ Photocell, No Relay)
    nES PDT 7 (Dual Technology, No Relay)
    nES PDT 7 ADCX (Dual Technology w/ Photocell, No Relay)

25. Network system shall also have ceiling, fixture, recessed, & corner mounted sensors available.
26. Sensors shall have optional features for photocell/daylight override, dimming control, and low temperature/high humidity operation.
27. Sensors shall be the following nLight model numbers, with device options as specified:

Model # Series	Occupancy Poles	# of Relays	Lens Type	Detection Technology
nCM(B) 9	1	-	Standard	PIR
nCM(B) 9 2P	2	-	Standard	PIR
nCM 9 RJB	1	-	Standard	PIR
nCM 9 2P RJB	2	-	Standard	PIR
nCM(B) PDT 9	1	-	Standard	Dual
nCM(B) PDT 9 2P	2	-	Standard	Dual
nCM PDT 9 RJB	1	-	Standard	Dual
nCM PDT 9 2P RJB	2	-	Standard	Dual
nCM(B) 10	1	-	Extended	PIR
nCM(B) 10 2P	2	-	Extended	PIR
nCM 10 RJB	1	-	Extended	PIR
nCM 10 2P RJB	2	-	Extended	PIR
nCM(B) PDT 10	1	-	Extended	Dual
nCM(B) PDT 10 2P	2	-	Extended	Dual
nCM PDT 10 RJB	1	-	Extended	Dual
nCM PDT 10 2P RJB	2	-	Extended	Dual
nRM 9	1	-	Standard	PIR
nRM PDT 9	1	-	Standard	Dual
nRM 10	1	-	Extended	PIR
nRM PDT 10	1	-	Extended	Dual
nRM 6	1	-	High Bay	PIR
nRM 50	1	-	Aisle Way	PIR
nWV 16	1	-	Wide View	PIR
nWV PDT 16	1	-	Wide View	Dual
nHW13	1	-	Hallway	PIR
nCM(B) 6	1	-	High Bay	PIR
nCM 6 RJB	1	-	High Bay	PIR

C. Networked system daylight (photocell and/or dimming) sensors

1. Photocell shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
2. Photocell and dimming sensor's set-point and deadband shall be automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set-point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.
3. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
4. Photocell and dimming sensors shall be equipped with an automatic override for100 hour burn-in of lamps. This feature must be available at any time for lamp replacements. (Note: This function should be performed prior to any dimming of the lamps including the "auto set-point" setting.)
5. Combination units that have all features of on/off photocell and dimming sensors shall also be available.
6. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The second zone shall be capable of being controlled as an "offset" from the primary zone.
7. Sensor shall be the following nLight model numbers, with device options as specified:

   nCM(B) PC (RJB) (on/off)
   nCM(B) PC DZ (RJB) (on/off control, dual zone)
   nCM(B) ADCX (RJB) (remote automatic dimming control photocell)
   nCM(B) ADCX DZ (RJB) (remote automatic dimming control photocell, dual zone)
   nRM PC (on/off)
   nRM PC DZ (on/off, dual zone)
   nRM ADCX (remote automatic dimming control photocell)
   nRM ADCX DZ (remote automatic dimming control photocell, dual zone)
8. Network system shall have dimming photocells that can be embedded into luminaire such that only the lens shows on luminaire face.
9. Embedded sensors shall be the following nLight model number:
   nES ADCX (Dimming Photocell)

D. Networked System Power (Relay) Packs

1. Power Packs shall incorporate one Class 1 relay, a 0-10 VDC dimming output, and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay and 0-10 VDC or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.
2. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system.
3. All devices shall have two RJ-45 ports.
4. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.
5. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.

6. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
7. Power Packs and Power Supplies shall be available that are WiFi enabled.
8. Power Packs (Secondary) shall be available that provide up to 16 Amp switching of all lighting load types.
9. Power Packs shall be available that provide up to 5 Amps switching of all lighting load types as well as 0-10 VDC dimming or fluorescent ballasts/LED drivers.
10. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).
11. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120/277 VAC magnetic low voltage transformers.
12. Specific Secondary Packs shall be available that provide up to 4 Amps of switching and can dim 120 VAC electronic low voltage transformers.
13. Specific Power/Secondary Packs shall be available that are UL924 listed for switching of Emergency Power circuits.
14. Specific Secondary Packs shall be available that control louver/damper motors for skylights.
15. Specific Secondary Packs shall be available that provide a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.
16. Power (Secondary) Packs shall be available that provide up to 20 Amps switching of general purposed receptacle (plug-load) control.
17. Power (Relay) Packs and Supplies shall be the following nLight model numbers:
    nPP16 (Power Pack w/ 16A relay)
    nPP16 D (Power Pack w/ 16A relay and 0-10VDC dimming output)
    nPP16 WIFI (Power Pack w/ 16A relay, WIFI enabled)
    nEPP5 D (Power Pack w/ 5A relay and 0-10VDC dimming output)
    nSP16 (Secondary Pack w/ 16A relay)
    nPP16 ER (UL924 Listed Secondary Pack w/ 16A relay for switching emergency power circuits)
    nPP16 D ER UL924 Listed Secondary Pack w/ 16A relay and 0-10VDC dimming output for switching/dimming emergency power circuits)
    nSP5 PCD 2W (Secondary Pack w/ 5A relay and incandescent dimming or 2-wire line voltage fluorescent dimming output)
    nSP5 PCD 3W (Secondary Pack w/ 5A relay and 3-wire line voltage fluorescent dimming output)
    nSP5 PCD MLV (Secondary Pack w/ 5A relay and magnetic low voltage dimming output)
    nSP5 PCD ELV 120 (Secondary Pack w/ 4A relay and electronic low voltage dimming output)
    nSP5 2P LVR (Louver/Damper Control Pack
    nSHADE (Pulse On/Off Control Pack
    nPP20 PL (Secondary Pack w/ 20A relay for general purpose receptacle load)
    nPS 80 (Auxiliary Bus Power Supply)
    nPS 80 WIFI (Auxiliary Bus Power Supply, WiFi enabled)
    nAR 40 (Low voltage auxiliary relay pack)

E. Networked System Relay & Dimming Panels

1. Panel shall incorporate up to 4 normally closed latching relays capable of switching 120/277 VAC or up to 2 Dual Phase relays capable of switching 208/240/480 VAC loads.
2. Relays shall be rated to switch up to a 30A ballast load at 277 VAC.
3. Panel shall provide one 0-10VDC dimming output paired with each relay.
4. Panel shall power itself from an integrated 120/277 VAC supply.

5. Panel shall be capable of operating as either two networked devices or as one.
6. Panel shall supply current limited low voltage power to other networked devices connected via CAT-5.
7. Panel shall provide auxiliary low voltage device power connected wired directly to a dedicated terminal connection.
8. Power (Relay) Packs and Supplies shall be the following nLight model numbers:
   nPANEL 4 (Panel w/ four 120/277 VAC relays and four 0-10 VDC dimming outputs)
   nPANEL 2 480 (Panel w/ two dual phase relays (208/240/480 VAC) and two 0-10 VDC dimming outputs)

F. Networked Auxiliary Input / Output (I/O) Devices
1. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½" knockout.
2. Devices shall have two RJ-45 ports
3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
4. Specific I/O devices shall have a dimming control output that can control 0-10 VDC dimmable ballasts or LED drivers by sinking up to 20 mA of current.
5. Specific I/O devices shall have an input that reads a 0-10 VDC signal from an external device.
6. Specific I/O devices shall have a switch input that can interface with either a maintained or momentary switch and run a switch event (toggle the lighting load) or run a local/remote control profile.
7. Specific I/O devices shall sense state of low voltage outdoor photocells.
8. Specific I/O devices shall enable RS-232 communication between lighting control system and Touch Screen based A/V control systems.
9. Specific I/O devices shall sense momentary and maintained contact closures, and either toggle a connected load after a momentary contact or ramp the load high/low during a maintained contact (stopping when the contact releases).
10. Auxiliary Input/Output Devices shall be the following nLight model numbers:
    nIO D (I/O device with 0-10 dimming output)
    nIO 1S or nIO RLX (I/O device with contact closure or 0-10VDC dimming input)
    nIO NLI (Input device for detecting state of low voltage outdoor photocell; sold in nIO PC KIT only)
    nIO X (Interface device for communicating with RS-232 enabled AV Touch Screens

G. Networked LED Luminaires
1. Networked LED luminaire shall have a mechanically integrated control device
2. Networked LED luminaire shall have two RJ-45 ports available (via control device directly or incorporated RJ-45 splitter)
3. Networked LED luminaire shall be able to digitally network directly to other network control devices (sensors, photocells, switches, dimmers)
4. Networked LED luminaire shall provide low voltage power to other networked control devices (excluding EMG versions)
5. System shall be able to turn on/off specific LED luminaires without using a relay, if LED driver supports "sleep mode"
6. System shall be able to maintain constant lumen output over the specified life of the LED luminaire (also called lumen compensation) by varying the input control power (and thus saving up to 20% power usage).
7. System shall indicate (via a blink warning) when the LED luminaire has reached its expected life (in hrs).
8. Integrated control devices shall be the following nLight model series:
   nIO LEDG (ER)
   nIO EZ PH (ER)
   nPS 80 EZ (ER)

nEPS 60 IO EZ
nEIO EZ LC (ER)
AVL

H. Networked System Wall Switches & Dimmers

1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
2. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
3. All devices shall have two RJ-45 ports.
4. All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.
5. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
6. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
7. Devices with mechanical push-buttons shall be made available with custom button labeling
8. Devices with a single “on” button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusion as to which of two buttons (as is present in multi-button scenarios) controls which load is eliminated.
9. Wall switches & dimmers shall be the following nLight model numbers, with device options as specified:
   nPODM (single on/off, push-buttons, LED user feedback)
   nPODM DX (single on/off, single dimming raise/lower, push-buttons, LED user feedback)
   nPODM 2P (dual on/off, push-buttons, LED user feedback)
   nPODM 2P DX (dual on/off, dual dimming raise/lower, push-buttons, LED user feedback)
   nPODM 4P (quad on/off, push-buttons, LED user feedback)
   nPODM 4P DX (quad on/off, quad dimming raise-lower, push-buttons, LED user feedback)

I. Networked System Graphic Wall Station

1. Device shall have a 3.5” full color touch screen for selecting up to 16 programmable lighting control preset scenes or acting as up to 16 on/off/dim control switches.
2. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
3. Device shall enable configuration of all switches, dimmers, and lighting preset scenes via password protected setup screens.
4. Device shall enable user supplied .jpg screen saver image to be uploaded.
5. Device shall surface mount to single-gang switch box.
6. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply.
7. Device shall have a micro-USB style connector for local computer connectivity.
8. Device shall have two RJ-45 ports for communication
9. Device shall be the following nLight model number:
   nPOD GFX

J. Networked System Scene Controllers

1. Device shall have two, three, four, or eight buttons for selecting programmable lighting control profiles or acting as on/off switches.
2. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
3. Device shall recess into single-gang switch box and fit a standard GFI opening.
4. Devices shall provide LED user feedback.
5. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

6. All devices shall have two RJ-45 ports.
7. Device shall be capable of reprogramming other devices in its zone so as to implement user selected lighting scene.
8. Device shall be capable of selecting a lighting profile be run by the system's upstream Gateway so as to implement selected lighting profile across multiple zones (and not just its local zone).
9. Device shall have LEDs indicating current selection.
10. Scene Selector device shall be the following nLight model number:
    nPODM 2S (2 Scene, push-button)
    nPODM 4S (4 Scene, push-button)
    nPODM 4S DX (4 Scene, push-button, On/Off/Raise/Lower)
    nPODM 2L (2 Adjustable Preset Levels, push-button, On/Off)
    nPODM 2L AB (2 Scene, push-button, On/Off/High/Low)
    nPODM 4L DX (4 Adjustable Preset Levels, push-button, On/Off/Raise/Lower)

K. Communication Bridges

1. Device shall surface mount to a standard 4" x 4" square junction box.
2. Device shall have 8 RJ-45 ports.
3. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to Control Gateway.
4. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or delivered via a CAT-5 cabled connection.
5. Device shall be capable of redistributing power from its local supply and connect lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.
6. Communication Bridge devices shall be the following nLight model numbers:
    nBRG 8 (8 Ports)

2.4. LIGHTING CONTROL PROFILES

A. Changes to the operation of the system shall be capable of being made in real-time or scheduled via lighting control profiles. These profiles are outlines of settings that direct how a collection of devices function for a defined time period.
B. Lighting control profiles shall be capable of being created and applied to a single device, zone of devices, or customized group of zones.
C. All relays and dimming outputs shall be capable of being scheduled to track or ignore information regarding occupancy, daylight, and local user switches via lighting control profiles.
D. Specific device parameters (e.g. sensor time delay and photocell set-point) shall be configurable via a lighting control profile.
E. All lighting control profiles shall be stored on the network control gateway device, with a system backup on the software's host server.
F. Lighting control profiles shall be capable of being scheduled to run according to the following calendar options: start date/hour/minute, end date/hour/minute, and sunrise/sunset +/- timed offsets.
G. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.
H. Daylight savings time adjustments shall be capable of being performed automatically, if desired.
I. Lighting control profile schedules shall be capable of being given the following recurrence settings: daily, weekday, weekend, weekly, monthly, and yearly.
J. Software shall provide a graphical tool for easily viewing scheduled lighting control profiles.

2.5. MANAGEMENT SOFTWARE

A. Every device parameter (e.g. sensor time delay and photocell set-point) shall be available and configurable remotely from the software

B. The following status monitoring information shall be made available from the software for all devices for which it is applicable: current occupancy status, current PIR Status, current Microphonics Status, remaining occupancy time delay(s), current photocell reading, current photocell inhibiting state, photocell transitions time remaining, current dim level, device temperature, and device relay state(s).
C. The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.
D. A printable network inventory report shall be available via the software.
E. A printable report detailing all system profiles shall be available via the software.
F. Software shall require all users to login with a User Name and Password.
G. Software shall provide at least three permission levels for users.
H. All sensitive stored information and privileged communication by the software shall be encrypted.
I. All device firmware and system software updates must be available for automatic download and installation via the internet.
J. Software shall be capable of managing systems interconnected via a WAN (wide area network)

2.6. BMS COMPATIBILITY

A. System shall provide a BACnet IP gateway as a downloadable software plug-in to its management software.
B. BACnet IP connection shall also be available utilizing JACE-600 hardware unit.
C. BACnet IP hardware shall be capable of supporting up to 1500 total devices across up to 5 total Gateways
D. BACnet IP connection shall communicate information gathered by networked system to other building management systems.
E. BACnet IP connection shall translate and forward lighting relay and other select control commands from BMS system to networked control devices via profiles stored in the system Gateway. All system devices shall be available for polling for devices status.
F. BACnet IP hardware device shall be the following nLight model name:
nBACnet

2.7. SYSTEM ENERGY ANALYSIS & REPORTING SOFTWARE

A. System shall be capable of reporting lighting system events and performance data back to the management software for display and analysis.
B. Intuitive graphical screens shall be displayed in order to facilitate simple viewing of system energy performance.
C. An “Energy Scorecard” shall be display that shows calculated energy savings in dollars, KWHr, or CO2.
D. Software shall calculate the allocation of energy savings to different control measures (occupancy sensors, photocells, manual switching, etc).
E. Energy savings data shall be calculated for the system as a whole or for individual zones.
F. A time scaled graph showing all relay transitions shall be presented.
G. A time scaled graph showing a zones occupancy time delay shall be presented
H. A time scaled graph showing the total light level shall be presented.
I. User shall be able to customize the baseline run-time hours for a space.
J. User shall be able to customize up to four time-of-day billing rates and schedules.
K. Data shall be made available via a .CSV file

2.8. START-UP & SUPPORT FEATURES

A. To facilitate start-up, all devices daisy-chained together (using CAT-5) shall automatically be grouped together into a functional lighting control zone.
B. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.
C. Once software is installed, system shall be able to auto-discover all system devices without requiring any commissioning.

D. All system devices shall be capable of being given user defined names.
E. All devices within the network shall be able to have their firmware upgraded remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.
F. All sensor devices shall have the ability to detect improper communication wiring and blink it's LED in a specific cadence as to alert installation/startup personnel.

2.9 LIGHTING CONTROL SEQUENCE OF OPERATION

a. Lighting control system:
b. Corridors:
On 100% during hours designated by owner, fixtures shall dim to 50% during overnight hours.
c. Vestibules:
On 100% during hours designated by owner, fixtures shall dim to 50% during overnight hours, energize to 100% upon occupancy.
d. Lobby:
On 100% during hours designated by owner, fixtures shall dim to 50% during overnight hours.
e. Lobby pendant:
On 100% during hours designated by owner, fixtures shall dim to 50% during overnight hours, off during owner designated hours.
f. Offices:
Standalone dimming with wall pod.
g. Fitness:
Standalone dimming with wall pod.
h. Club room:
Standalone dimming with wall pod.
i. Lightbridge:
Dimming; lighting sequence by others, coordinate power and and zone quantity with light bridge designer.
j. Exterior building mount lighting:
Dimming, lighting sequence by others.
Line voltage control:
k. Storage and back of house:
Occupancy sensor control, on/off.
l. Public bathrooms
Occupancy sensor control, on/off.
m. Storage rooms:
Occupancy sensor control, on/off.

END OF SECTION 260943

SECTION 261310 – ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. System operation and card encoding system.
2. Online lock control system.
3. Electromechanical tenant room locks.
4. Electromechanical common area locks.
5. Remote card readers.
6. Access control system application software.
7. Access credentials.

B. Related Sections:

1. Division 01 Section "General Requirements”.
2. Division 08 Section “Door Hardware Schedule”.
3. Division 08 Section “Hollow Metal Doors and Frames”.
4. Division 08 Section “Wood Doors”.
5. Division 08 Section “Aluminum-Framed Entrances and Storefronts”.
6. Division 08 Section “Door Hardware”
7. Division 14 Section “Elevators”.
8. Division 26 Section “Electrical”.

C. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ICC/IBC - International Building Code.
3. NFPA 80 - Fire Doors and Windows.
4. NFPA 101 - Life Safety Code.
5. NFPA 105 - Installation of Smoke Door Assemblies.
6. FCC Part 15 Subpart C.
7. State Building Codes, Local Amendments.

D. Standards: All hardware specified herein shall comply with the following industry standards:

1. ANSI/BHMA Certified Product Standards - A156 Series
2. UL10C – Positive Pressure Fire Tests of Door Assemblies.

1.3 SUBMITTALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. System Operational Descriptions: Complete system operational narratives for the integrated access controlled openings defining the owner's prescribed requirements for the opening functionality. Narratives include, but are not limited to, the following situations: normal secured/unsecured state of door; authorized access; authorized egress; unauthorized access; unauthorized egress; fire alarm and loss of power conditions, and interfaces with other building control systems.

C. Shop Drawings: Details of electrified access control hardware indicating the following:

1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

    a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
    b. Complete (risers, point-to-point) access control system block wiring diagrams.

2. Electrical Coordination: Coordinate with related Division 26 Electrical Sections the voltages and wiring details required at electrically controlled and operated hardware openings.

D. Proof of Certification: Provide copy of manufacturer(s) official certification or accreditation document indicating proof of status as a qualified and authorized provider of the primary access control components.

E. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware and site management installation in quantity as required in Division 01, Closeout Submittals. The manual to include the name, address, and contact information of the manufacturers providing the hardware and their nearest service representatives. The final copies delivered after completion of the installation test to include "as built" modifications made during installation, checkout, and acceptance.

F. Warranties and Maintenance: Special warranties and maintenance agreements specified in this Section.

1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 3 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Installer Qualifications: Installers trained and certified by the product manufacturer.

C. Certified integrator must provide a minimum 90 days advanced notice to the facility owner/manager and Manufacturer prior to system closure or transfer.

D. Source Limitations: Obtain the access control door hardware, system firmware and application software specified in this Section from a single source, qualified supplier/integrator unless otherwise indicated.

E. Regulatory Requirements: Comply with NFPA 70, NFPA 80, NFPA 101 and ANSI A117.1 requirements and guidelines as directed in the model building code including, but not limited to, the following:

1. NFPA 70 "National Electrical Code", including electrical components, devices, and accessories listed and labeled as defined in Article 100 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

2. Where indicated to comply with accessibility requirements, comply with Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)," ANSI A117.1 as follows:

   a. Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.

3. NFPA 101: Comply with the following for means of egress doors:

   a. Latches, Locks, and Exit Devices: Not more than 15 lbf to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.

4. Fire-Rated Door Assemblies: Provide door hardware for assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252 (neutral pressure at 40" above sill) or UL-10C.

   a. Test Pressure: Positive pressure labeling.

F. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing system components.

1. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
2. Review and finalize construction schedule and verify availability of materials.
3. Review the required inspecting, testing, commissioning, and demonstration procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inventory components upon receipt and provide secure lock-up and shelving. Do not store electronic locks, software or accessories at Project site without prior authorization.

B. Tag each lockset or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver, as applicable, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service.

1.6 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing electrified door hardware and access control system components.

B. System Survey: Prior to ordering the system, review the construction documents to determine the correct number and locations of wired and/or wireless lock gateways, routers, repeaters and updaters.

1. Wireless survey, where applicable, to support ZigBee® and ZWave® applications.
2. Data-on-Card applications are supported by Updaters.

C. Electrical Connections: Coordinate the layout and installation of scheduled electrified door and related access control equipment with required connections to source power junction boxes, low voltage power supplies and Power over Ethernet switches as applicable.

1.7 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
3. Electrical component defects and failures within the systems operation.

C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.

D. Special Warranty Periods:

nexTouch NTB600 Series Cylindrical Lock:	3 year Electrical, 3 year Mechanical, 1 year Finish
YRL YRD600 Series Deadbolt Lock:	1 year Electrical, 3 year Mechanical, 1 year Finish
YRL YRC600 Series Interconnected Lock:	1 year Electrical, 3 year Mechanical, 1 year Finish
Yale R10, R40 SE SEOS Updater:	Limited Lifetime Electrical
Controller:	1 year Electrical

1.8 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed by certified integrator for continued adjustment, maintenance, and removal and replacement of system components.

1.9 SCOPE OF WORK

A. Access Control Site Management System: Furnish and install at the indicated locations the specified integrated access control door hardware and access control system firmware and software for a completely operational access control. System includes, but is not necessarily limited, to the following:

1. Electrified integrated access control locks, network switches, updaters, door position switches, remote card readers, keypads, access cards and credentials, system application software (mobile device application), special tools, operating manuals, and required cabling and accessories as detailed below and listed in the Access Control Hardware Sets at the end of Part 3.

a. Provide manufacturer approved integrated access control locks, exit hardware, and remote mounted card readers, keypads, and updaters that are functionally compatible with the specified access control equipment interfaces.

B. Owner to provide the following:

1. Internet accessible devices that support current browser software.

2. Mobile devices run an Android OS, thus capable of accepting the mobile configuration application.

C. Electrical contractor, Division 26, to provide the following:

1. Power Sourcing, Network Switches, Power over Ethernet: Quantity as required to accommodate installed access control devices.

2. Power Supplies, including battery or uninterrupted backup power supply (UPS) and separately fused surge protection, required for the electrified door hardware, access control equipment, and PoE switches or wireless routers driving the integrated card reader locking devices.

3. Installation, final configuration and commissioning of electrified door and access control system hardware, power supplies and related accessories.

4. Network Control Connections: LAN/Ethernet communication ports (jacks) and network interface cards as needed, CAT5e (CAT6) cabling from network router/switch to networked updater, outlet and cover plates and/or patch cables required for network connection.

5.

6. System application and cloud services and mobile application including installation, programming, and end user training of the access control system demonstrating operating, repair, and maintenance procedures.

7. Source power wiring (120VAC) as required for the integrated locking and access control hardware, equipment, accessories and power supplies. This includes quad outlets as required on a dedicated circuit and the related conduit, stub-in, junction boxes and connectors required for the source power delivery and connections.

8. Provide required conduit, stub-in, junction and back boxes for both the electrified locking hardware and access control equipment at each of the access controlled or monitored openings per plan drawings and specs. Supply and install conduit between each of the

aforementioned devices and between the electrical junction boxes, power supplies and access control equipment located on or above the door opening.

a. At wall mounted remote readers, provide conduit on the secured side of the door, 36" from the finish floor and 6" from the edge of the frame, to the related power supplies and access control equipment.
b. At electrical hardware power transfers provide conduit on the secured side of the opening from the power transfer, thru-wire hinge, or serviceable panel location on the frame jamb to the related power supplies and access control equipment.

9. Electrical Contractor to provide all 120VAC cabling connections and terminations from the electrical junction boxes to these electrical devices.

D. Access Control System Integrator to provide the following, as coordinated and provided by Electrical Contractor :

1. Low voltage wiring (12/24VDC) and communication cabling (RS-485) from updaters to readers, electrified and integrated locking hardware, keypads, and power supplies. Work includes related connectors, final terminations, and hook-ups required for a complete and functional access controlled opening in accordance with applicable codes and specified system operational narratives.

E. Elevator Contractor to provide the following:

1. Interface or landing of interface cable onto the elevator call button will be performed by a certified elevator contractor.

2. Coordinate with certified integrator provisions for a card reader with output allowing the elevator call button to be activated. A validated card reader and updater will be required for activation.

F. Final connections to fire alarm system, if required, by Electrical Contractor.

1. Provide permits, submittals and approvals required by the authority having jurisdiction, prior to commencing with work.

PART 2 - PRODUCTS

2.1 ACCESS CONTROL EQUIPMENT AND SOFTWARE

A. System Server: Server is public-cloud based and supports all major operating system environments for client stations

1. Client Requirements:
   a. Operating Systems: Currently supported versions of Windows, Mac OS, Linux, Apple iOS, or Android OS 32 or 64 bit.
   b. Browser: Currently supported browser or smartphone browser application that fully supports Java, Firefox, Chrome or similar.
   c. Ethernet or Wireless Network Card.

B. System Software: Provide software compatible with the operating system provided and WAN/LAN networking. Provide software with HTTPS addressing capabilities, and capability to interface with the major Property Management Systems (PMS).

1. Software System Features:

a. 2,000,000 unique user ID's.
b. Unlimited Enrollment stations.
c. Unlimited Door controllers.
d. Unlimited credential Updaters (with Door Control).
e. User-definable schedules.
f. Unlimited cloud accessible audit history.
g. PMS Interface through TCP/IP, XML formatted personnel data.

C. Mobile Configuration Application: Provide a configuration application which is compatible with an Android OS.

1. Configures time and date for both locks and controllers.
2. Assigns unique identities to all devices within the system.
3. Displays audit trail.
4. Controls local lock settings and master code.

D. Offline System Option: This facility will operate with offline lock programming and control of common area and tenant doors.

E. Online Ready System Option: Optionally the offline locks can be upgraded to wireless operation, for possible future operation as an online system connected to a third party application provider.

F. Basis of Design Manufacturers, or approved equivalent:

1. Yale Locks and Hardware (YA) – Accentra for Multi-Family.

2.2 SYSTEM COMPONENTS AND TECHNOLOGY

A. The system shall provide the ability to operate as online doors for the purposes of both access control and encoding/updating credentials. Provide the necessary network and lock components to create an online lock control system at the perimeter of the building. Utilize standard Ethernet and Power over Ethernet (PoE) as the communication backbone between the system server and the wired (on-line) doors and updaters.

B. System Requirements:

1. Updaters must effectively function as an offline locking system if online communication is interrupted.

2. Must provide 'live' control of online updaters, cards, and individual users from a central or remote location.

3. Must allow tenant and staff cards to be changed, extended, or cancelled from a central or remote location. Tenant cards are automatically cancelled upon move-out.

4. Tenants who are locked out (lost or forgotten credential) shall be able to obtain a onetime PIN code from the systems software, with proper authorization.

5. Must be possible to display lock audit trails from a central or remote location.

6. Must be able to provide a continuously (and automatically) updated system audit trail showing lock motor jammed, low battery, credential accepted and rejected alerts.

C. Lock Communication: Provide locks with RFID read/write capabilities to provide the communication link between the system server and the lockset over Data-on-Card transport mechanism. Hard wiring between the tenant door and frame is not acceptable.

D. Credential Updaters/Controller combination: Provide Yale Accentra R10/40 OSDP SE Updaters compatible with: ISO 14443A. Provide system capable of supporting an unlimited number of enrollment stations and/or updaters acting as single door controllers. Controller directly connects into the LAN/WAN network, using DHCP, DNS and TCP/IP addressing with automatic self-configuration functionality to reduce the need for on-site configuration. Controller can be powered by PoE switches (specified in the electrical section), or by a 24VDC power supply.

2.3 DATA ON CARD ACCESS CONTROL LOCKS

A. Data on Card Access Control Cylindrical Locks: ANSI/BHMA A156.2 Series 4000, Grade 1 cylindrical lockset with integrated key pad for access and programming. Voice guided programming and 4-8 digit code selection for a one time PIN code backup feature. Optional key override feature to accept standard, interchangeable core, security, and patented cylinders.

1. Fully-encrypted AES 128 NFC wireless communication between lock and Yale Seos® credentials.

2. Seos® card reader included within the lock.

3. System Capacity: 5,000 users.

4. Motorized locking and unlocking.

5. Programming Language: English (default), Spanish, or French.

6. User Interface:

    a. Capacitive Touchscreen.

7. Audit Trail: 200 Events internal, unlimited audits in the cloud management system.

8. Unlocking Modes:

    a. Key override (momentary)
    b. One time PIN code (4-8 digits)
    c. Yale SEOS card or fob credential.

9. Locking Modes:

    a. Automatic relocking with available variable timing.
    b. One touch keypad locking.
    c. PIN Code keypad locking (prior to commissioning).
    d. Locking button on interior escutcheon.

10. Optional Locking Modes (Requires external door position switch):

    a. Privacy mode.
    b. Wrong Try Shutdown.

11. Lock access options:

    a. Up to 25 4-8 digit PIN codes (prior to commissioning).
    b. One time PIN code (after commissioning).
    c. Yale Seos® credentials (after commissioning).

12. Power Source:

    a. 4 AA alkaline batteries (standard).
    b. External 9 VDC regulated power supply (option).
    c. 9 VDC transistor battery backup terminal at the keypad (emergency).

13. Basis of Design Manufacturers, or approved equivalent:

    a. Yale Commercial (YA) – nexTouch NTB600-ACC Series.

B. Data on Card Access Control Deadbolts: ANSI/BHMA A156.36 Series 4000, Grade 2 deadbolt with integrated key pad for access and programming. Voice guided programming and 4-8 digit code selection for a one time PIN code backup feature. Optional key override feature to accept standard, interchangeable core, security, and patented cylinders. Prior to commissioning, lock functions as a standalone lock with PIN code management.

1. Fully-encrypted AES 128 NFC wireless communication between lock and Yale Seos® credentials.

2. Seos® card reader included within the lock.

3. System Capacity: 5,000 users.

4. Motorized locking and unlocking.

5. Programming Language: English (default), Spanish, or French.

6. User Interface: Capacitive Touchscreen.

7. Audit Trail: 200 Events internally, unlimited audits in the cloud management system.

8. Unlocking Modes:

    a. Key override.
    b. One time PIN code (4-8 digits).
    c. SEOS card or fob credential.

9. Locking Modes:

    a. Automatic relocking with available variable timing.
    b. One touch locking.
    c. Interior manual thumbturn.
    d. PIN Code keypad locking (prior to commissioning).

10. Optional Locking Modes (Requires external door position switch):

    a. Privacy mode.
    b. Escape-return mode.
    c. Wrong Try Shutdown.

11. Lock access options:
    a. Up to 25 4-8 digit PIM codes (prior to commissioning).
    b. One time PIN code (after commissioning).
    c. Yale Seos® credentials (after commissioning).

12. Power Source: 4 AA alkaline batteries.

13. Basis of Design Manufacturers, or approved equivalent:

    a. Yale Residential (YR) – Yale Real Living YRD620-ACC Series.

C. Data on Card Access Control Interconnected Locks: ANSI/BHMA A156.2 Series 4000, Grade 2 interconnected lock with integrated key pad for access and programming. Voice guided programming and 4-8 digit code selection for a one time PIN code backup feature. Optional key override feature to accept standard, interchangeable core, security, and patented cylinders. Prior to commissioning, lock functions as a standalone lock with PIN code management.

1. Fully-encrypted AES 128 NFC wireless communication between lock and Yale Seos® credentials.

2. Seos® card reader included within the lock.

3. System Capacity: 5,000 users.

4. Motorized locking and unlocking.

5. Programming Language: English (default), Spanish, or French.

6. User Interface: Capacitive Touchscreen.

7. Audit Trail: 200 Events internally, unlimited audits in the cloud management system.

8. Unlocking Modes:

    a. Key override.
    b. One time PIN code (4-8 digits).
    c. SEOS card or fob credential.
    d. Interior manual thumbturn.

9. Locking Modes:

    a. Automatic relocking with available variable timing.
    b. One touch locking.
    c. Interior manual thumbturn.
    d. PIN Code keypad locking (prior to commissioning).

10. Optional Locking Modes (Requires external door position switch):

    a. Privacy mode.

b. Escape-return mode.
c. Wrong Try Shutdown.

11. Lock access options:

a. Up to 25 4-8 digit PIM codes (prior to commissioning).
b. One time PIN code (after commissioning).
c. Yale Seos® credentials (after commissioning).

12. Power Source: 4 AA alkaline batteries.

13. Basis of Design Manufacturers, or approved equivalent:

a. Yale Residential (YR) – Yale Real Living YRC620-ACC Series.

2.4 REMOTE CREDENTIAL UPDATERS

A. Networked Contactless Smart Card Updaters: Contactless smart card updaters to securely read information from and write access control data to 13.56 MHz contactless smart cards. The contactless smart card updater is designed for use in access control applications by providing:

1. Secure access control data exchange between the smart card and the updater utilizing key diversification and mutual authentication routines.
2. Contactless smart card updater to be designed for low current operation to enable migration from most legacy proximity applications without the need to replace existing access control panels and/or power supplies. Operating voltage: 5-16 VDC. Current requirements: 55 mA Avg, 116 mA Peak at 12 VDC.
3. Universal compatibility with most access control systems.
4. Product construction suitable for both indoor and outdoor applications.
5. Customizable behavior for indicator lights and audible tones.

6. Basis of Design Manufacturers, or approved equivalent (13.56 MHz iClass):

a. Yale (YA) - R10/R40 Series.

2.5 CREDENTIALS

A. Provide secure RFID credentials that meet NIST requirements for encryption and HIPAA requirements for patient information security as required by the access control system specified herein. Card technology shall provide protection against surreptitious tracking of the credential by means of random Card Serial Number (CSN) generation. Cards shall additionally provide a second layer of anti-cloning encryption to eliminate card duplication, as well as provide digital certificates which can be used for mobile access transactions. Credentials are to be capable of resisting tearing, bending, scratching, and moisture.

B. Contactless Smart Cards: Contactless smart cards incorporating an access control identification technology that utilizes 13.56 MHz radio frequency (RF) circuits in microchip form. The microchips are encoded and securely transmit the encoded information when activated.

1. Technology features:

a. Available in 8K-Bytes.

b. AES-128 bits cryptographic algorithms for data protection.
c. Hardware chip integrating co-processor with high performance for cryptographic calculations with symmetric keys.

2. Security features:

a. Programmable with one or several Secure Identity Objects® (SIOs®) for each application.

3. Single technology contactless features:

a. iCLASS Seos with 8K processor card for standard applications leverages SIO data model and security.

4. Interoperability:

a. Fully supported by iCLASS SE® and multiCLASS SE® readers that can process SIO-enabled data formats. Only supported by iCLASS SE readers with firmware Revision E or later.

5. Quantity: Include three per tenant room. Coordinate additional card quantities with the facility manager.

6. Basis of Design Manufacturers, or approved equivalent (13.56 MHz iClass Seos):

a. Yale - 500x iCLASS® Seos®

C. Key Fobs: Fobs incorporating an access control identification technology that utilizes 13.56 MHz radio frequency (RF) circuits in microchip form. The microchips are encoded and securely transmit the encoded information when activated.

1. Technology features:

a. Available in 8K-Bytes.
b. AES-128 bits cryptographic algorithms for data protection.
c. Hardware chip integrating co-processor with high performance for cryptographic calculations with symmetric keys.

2. Security features:

a. Programmable with one or several Secure Identity Objects® (SIOs®) for each application.

3. Single technology contactless features:

a. iCLASS Seos with 8K processor card for standard applications leverages SIO data model and security.

4. Interoperability:

a. Fully supported by iCLASS SE® and multiCLASS SE® readers that can process SIO-enabled data formats. Only supported by iCLASS SE readers with firmware Revision E or later.

5. Quantity: Include three per tenant room. Coordinate additional fob quantities with the facility manager.

6. Basis of Design Manufacturers, or approved equivalent (13.56 MHz iClass Seos):

   a. Yale - 500x iCLASS® Seos®.

2.6 FABRICATION

A. Fasteners: Provide system components manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.7 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with requirements for installation tolerances, labeled fire door assembly construction, and other conditions affecting performance.

B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

A. Install each item to comply with manufacturer's written instructions and according to specifications.

   1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of products including but limited to: front desk equipment and software, remote controllers, electromechanical exit devices, and unit room locks.

B. Storage: Provide a secure lock up for materials delivered to the project but not yet installed. Control the handling and installation of items so that the completion of the work will not be delayed by material losses before and after installation.

3.4 FIELD QUALITY CONTROL

A. Field Inspection: Supplier will perform a final inspection of installed components and state in report whether work complies with or deviates from requirements, including whether components are properly installed, operating and adjusted.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating unit and each door lock to ensure proper operation. Replace units that cannot be adjusted to operate as intended.

B. Wireless System Confirmation: Conduct a site survey using a wireless signal strength meter to ensure that all online locks are receiving an adequate wireless signal. Add additional gateways/routers as needed.

3.6 CLEANING AND PROTECTION

A. Protect all components stored on construction site in a covered and dry place. Protect installed components during the construction phase. Install components at the latest possible time frame.

B. Clean components as necessary to restore proper finish. Provide final protection and maintain conditions that ensure components are without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

A. Instruct Owner’s managerial personnel on the correct use and troubleshooting of the updater, configuration application, and cloud service components.

B. Instruct Owner's maintenance personnel to adjust, operate, and maintain electromechanical door hardware.

3.8 DOOR HARDWARE SCHEDULE

A. Refer to Section 080671, Door Hardware Schedule, for hardware sets.

END OF SECTION 281300

SECTION 262442 - PANELBOARDS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes distribution and branch circuit panelboards, electronic grade branch circuit panelboards, and load centers.

B. Related Sections:
   1. Division 26 - Grounding and Bonding.
   2. Division 26 - Electrical Identification

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:
   1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

B. National Electrical Manufacturers Association:
   1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
   2. NEMA FU 1 - Low Voltage Cartridge Fuses.
   3. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contractors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
   4. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
   5. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
   6. NEMA PB 1 - Panelboards.
   7. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.

C. International Electrical Testing Association:
   1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

D. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code.

E. Underwriters Laboratories Inc.:
   1. UL 67 - Safety for Panelboards.
   2. UL 1283 - Electromagnetic Interference Filters.
   3. UL 1449 - Transient Voltage Surge Suppressors.

1.3 SUBMITTALS

A. Division 1 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

C. Product Data: Submit catalog data showing specified features of standard products.

1.4 CLOSEOUT SUBMITTALS

A. Division 1 - Closeout Submittals: Requirements for submittals.

B. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements.

C. Operation and Maintenance Data: Submit spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.6 MAINTENANCE MATERIALS

A. Division 1 - Execution Requirements and Operation and Maintenance Data: Requirements for maintenance products.

B. Furnish two of each panelboard key. Panelboards keyed alike.

PART 2 PRODUCTS

2.1 DISTRIBUTION PANELBOARDS

A. Manufacturers:
1. Same as MDP manufacturer.
2. Substitutions: Not Permitted.

B. Product Description: NEMA PB 1, circuit breaker type panelboard.

C. Panelboard Bus: Copper current carrying components, ratings as indicated on Drawings. Furnish copper ground bus in each panelboard.

D. Minimum integrated short circuit rating: 22,000 amperes rms symmetrical.

E. Molded Case Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Furnish circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.

F. Molded Case Circuit Breakers with Current Limiters: NEMA AB 1, circuit breakers with replaceable current limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole.

G. Current Limiting Molded Case Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 22,000 symmetrical amperes, let-through current and energy level less than permitted for same size NEMA FU 1, Class RK-5 fuse.

H. Circuit Breaker Accessories: Trip units and auxiliary switches as indicated on Drawings.

I. Enclosure: NEMA PB 1, Type 1.

J. Cabinet Front: Surface (in mechanical and electrical rooms only) or recessed type, fastened with concealed trim clamps, door-in-door construction, metal directory frame, finished in manufacturer's standard enamel.

2.2 BRANCH CIRCUIT PANELBOARDS

A. Manufacturers:
1. Same as MDP manufacturer.
2. Substitutions: Not Permitted.

B. Product Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

C. Panelboard Bus: Copper current carrying components, ratings as indicated on Drawings. Furnish copper ground bus in each panelboard and furnish insulated ground bus.

D. Minimum Integrated Short Circuit Rating: 22,000 amperes rms symmetrical.

E. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Class A ground fault interrupter circuit breakers as indicated on Drawings. Do not use tandem circuit breakers.

F. Current Limiting Molded Case Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size NEMA FU 1, Class RK-5 fuse.

G. Enclosure: NEMA PB 1, Type 1.

H. Cabinet Box: 5 inches deep, 20 inches wide.

I. Cabinet Front: Flush or Surface (in mechanical/electrical rooms only) cabinet front with concealed trim clamps, door-in-door construction, concealed hinge, metal directory frame, and flush lock keyed alike. Finish in manufacturer's standard enamel.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with NEMA PB 1.1.

B. Install panelboards plumb.

C. Install recessed panelboards flush with wall finishes.

D. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.

E. Install filler plates for unused spaces in panelboards.

F. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes to balance phase loads.

G. Install engraved plastic nameplates in accordance with Division 16.

H. Install spare conduits out of each recessed panelboard to accessible location [above ceiling or below floor. Minimum spare conduits: 2 empty 1-1/2 inch, 3 empty 1 inch . Identify each as SPARE.

I. Ground and bond panelboard enclosure according to Division 16. Connect equipment ground bars of panels in accordance with NFPA 70.

3.2 FIELD QUALITY CONTROL

A. Division 1 - Quality Requirements: Testing and Inspection Services; Execution Requirements: Testing, adjusting, and balancing.

B. Perform circuit breaker inspections and tests listed in NETA ATS, Section 7.6.

C. Perform switch inspections and tests listed in NETA ATS, Section 7.5.

D. Perform controller inspections and tests listed in NETA ATS, Section 7.16.1.

3.3 ADJUSTING

A. Division 1 - Execution Requirements; Starting and Adjusting: Requirements for starting and adjusting.

B. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION 262442

SECTION 262726 - WIRING DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Wall switches.
   2. Receptacles.
   3. Device plates and decorative box covers.

B. RELATED SECTIONS
   1. Section 260533 – Raceway and Boxes.

1.2 REFERENCES

A. NECA - Standard of Installation.

B. NEMA WD 1 - General Requirements for Wiring Devices.

C. NEMA WD 6 - Wiring Device -- Dimensional Requirements.

D. NFPA 70 - National Electrical Code.

1.3 SUBMITTALS FOR REVIEW

A. Division 1 - Submittals: Procedures for submittals.

B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

C. Coordinate color of all devices and cover plates with the Architect.

1.4 SUBMITTALS FOR INFORMATION

A. Division 1 - Submittals: Submittals for information.

B. Submit manufacturer's installation instructions.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section.

1.6 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Provide Products listed and classified by Underwriters Laboratories, Inc.

PART 2 PRODUCTS

2.1 WALL SWITCHES

A. Single Pole Switch:
1. Hubbell Model HBL1221-X (X= color per Architect).
2. Equal by Bryant.
3. Equal by Pass & Seymour.

B. Double Pole Switch:
1. Hubbell Model HBL1222-X (X= color per Architect).
2. Equal by Bryant.
3. Equal by Pass & Seymour.

C. Three-way Switch:
1. Hubbell Model HBL1223-X (X= color per Architect).
2. Equal by Bryant.
3. Equal by Pass & Seymour.

D. Four-way Switch:
1. Hubbell Model HBL1224-X (X= color per Architect).
2. Equal by Bryant.
3. Equal by Pass & Seymour.

E. Indicator Switch:
1. Hubbell Model HBL1221-PL.
2. Equal by Bryant.
3. Equal by Pass & Seymour.

F. Locator Switch:
1. Hubbell Model HBL1221-ILC.
2. Equal by Bryant.
3. Equal by Pass & Seymour.

G. Keyed Switch:
1. Hubbell Model HBL1221-L w/ Key.
2. Equal by Bryant.
3. Equal by Pass & Seymour.

H. Substitutions: Refer to Division 1.

I. Color: Per Architect.

J. Ratings:
1. Voltage: 120-277 volts, AC, except pilot lit and indicator switches shall have a voltage matching the load served.
2. Current: 20 amperes.
3. Match branch circuit and load characteristics.

2.2 RECEPTACLES

A. Single Convenience Receptacle:
1. Hubbell Model 5361-X (X = color by Architect).
2. Equal by Bryant.
3. Equal by Pass & Seymour.

B. Duplex Convenience Receptacle:
   1. Hubbell Model 5362-X (X= color per Architect).
   2. Equal by Bryant.
   3. Equal by Pass & Seymour.

C. GFCI Receptacle:
   1. Hubbell Model GF-5362-X (X= color per Architect).
   2. Equal by Bryant.
   3. Equal by Pass & Seymour.

D. Special Purpose Receptacle:
   1. Hubbell Model to match load and phase requirements.
   2. Equal by Bryant.
   3. Equal by Pass & Seymour.

E. Telephone and Cable:
   1. EC to provide complete rough-in including backboards, power, raceway, boxes and plaster rings. Phone and data wiring will be by the owner's data/com contractor

F. Substitutions: Refer to Division 1.

G. Color: Per Architect.

H. Description: Commercial grade, 120 volt, 20 ampere, general use receptacle.

I. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

2.3 WALL PLATES

A. Decorative Cover Plate: Provide stainless steel cover plates in unfinished areas and on block walls unless instructed otherwise by the project architect. In finished areas provide nylon plates with color to match associated devices.
   1. Bryant
   2. Hubbell
   3. Mulberry
   4. Substitutions: Refer to division 1.

B. Weatherproof Cover Plate: Gasketed cast metal with hinged gasketed device cover.
   1. Appleton.
   2. Raco.
   3. O/Z Gendey.
   4. Substitutions: Refer to Division 1.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that outlet boxes are installed at proper height.

B. Verify that wall openings are neatly cut and will be completely covered by wall plates.

C. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

D. Verify that openings in access floor are in proper locations.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Install in accordance with NECA "Standard of Installation."

B. Install devices plumb and level.

C. Install switches with OFF position down.

D. Install receptacles with grounding pole on top.

E. Connect wiring device grounding terminal to outlet box with bonding jumper connected to box and branch circuit equipment grounding conductor.

F. Install decorative plates on switch, receptacle, and blank outlets in finished areas.

G. Connect wiring devices by wrapping conductor around screw terminal.

H. In equipment rooms use jumbo size plates for outlets installed in masonry walls.

I. Install stainless steel plates on outlet boxes and junction boxes in unfinished areas, kitchens, above accessible ceilings, and on surface mounted outlets.

J. Install protective rings on active flush cover service fittings.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations of outlet boxes provided under Section 260533 to obtain mounting heights specified and as indicated on the drawings.

B. Install wall switch 48 inches above finished floor.

C. Install convenience receptacle 18 inches above finished floor.

D. Install convenience receptacle 6 inches above counter or backsplash of counter, or as specified on the drawings.

E. Install telephone and cable boxes 18 inches above finished floor.

F. Install telephone jack for side-reach wall telephone to position top of telephone at 48 inches above finished floor.

G. Install telephone jack for forward-reach wall telephone to position top of telephone at 48 inches above finished floor.

3.5 FIELD QUALITY CONTROL

A. Division 1 - Quality Control.

B. Inspect each wiring device for defects.

C. Operate each wall switch with circuit energized and verify proper operation.

D. Verify that each receptacle device is energized.

E. Test each receptacle device for proper polarity.

F. Test each GFCI receptacle device for proper operation.

G. Verify that each telephone jack is properly connected and circuit is operational.

3.6 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.7 CLEANING

A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION 262726

SECTION 262800 - WIRING CONNECTIONS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes electrical connections to equipment.

B. Related Sections:
1. Section 260519 - Building Wire and Cable.
2. Section 260533 - Raceway and Boxes.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA WD 1 - General Requirements for Wiring Devices.
2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.3 SUBMITTALS

A. Division 1 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit wiring device manufacturer’s catalog information showing dimensions, configurations, and construction.

C. Manufacturer's installation instructions.

1.4 CLOSEOUT SUBMITTALS

A. Division 1 - Execution Requirements: Submittal procedures.

B. Project Record Documents: Record actual locations, sizes, and configurations of equipment connections.

1.5 COORDINATION

A. Division 1 - Administrative Requirements: Coordination and project conditions.

B. Obtain and review shop drawings, product data, manufacturer’s wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.

C. Determine connection locations and requirements.

D. Sequence rough-in of electrical connections to coordinate with installation of equipment.

E. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 1 - Administrative Requirements: Coordination and project conditions.

B. Verify equipment is ready for electrical connection, for wiring, and to be energized.

3.2 EXISTING WORK

A. Remove exposed abandoned equipment wiring connections.

B. Disconnect abandoned utilization equipment and remove wiring connections. Remove abandoned components when connected raceway is abandoned and removed. Install blank cover for abandoned boxes and enclosures not removed.

C. Extend existing equipment connections using materials and methods compatible with existing electrical installations, or as specified.

3.3 INSTALLATION

A. Make electrical connections.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Install receptacle outlet to accommodate connection with attachment plug.

E. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

F. Install terminal block jumpers to complete equipment wiring requirements.

G. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

3.4 ADJUSTING

A. Division 1 - Execution Requirements: Testing, adjusting, and balancing.

B. Cooperate with utilization equipment installers and field service personnel during checkout and starting of equipment to allow testing and balancing and other startup operations. Provide personnel to operate electrical system and checkout wiring connection components and configurations.

END OF SECTION 262800

SECTION 262810 - MOTORS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes single- and three-phase motors for application on equipment provided under other sections.

B. Related Sections:
   1. Section 260553 - Electrical Identification

1.2 REFERENCES

A. American Bearing Manufacturers Association:
   1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. National Electrical Manufacturers Association:
   1. NEMA MG 1 - Motors and Generators.

C. International Electrical Testing Association:
   1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

A. Division 1 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.

C. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Testing Agency: Company specializing in testing products specified in this section with minimum three years experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Division 1 - Product Requirements: Product storage and handling requirements.

B. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.

C. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.

D. For extended outdoor storage, remove motors from equipment and store separately.

E.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Division 1 - Product Requirements.

PART 2 PRODUCTS

2.1 PRODUCT REQUIREMENTS FOR MOTORS FURNISHED WITH EQUIPMENT

A. Motors 1 hp and Larger: Three-phase motor as specified below.

B. Motors Smaller Than 1/2 hp: Single-phase motor as specified below, except motors less than 250 watts or 1/4 hp may be equipment manufacturer's standard.

C. Three-Phase Motors: High efficiency squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds as indicated on Drawings. Provide high efficiency, inverter duty type motors for use with variable frequency drives. All pump motors shall be non-overloading.
   1. Voltage: 208 and 460 volts, three phase, 60 Hz.
   2. Service Factor: Minimum of 1.15
   3. Enclosure: Meet conditions of installation unless specific enclosure is indicated on Drawings.
   4. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
   5. Insulation System: NEMA Class F.
   6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
   7. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
   8. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
   9. Sound Power Levels: Conform to NEMA MG 1.

D. Single Phase Motors:
   1. Permanent split-capacitor type where available, otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
   2. Voltage: 115 volts, single phase, 60 Hz.

E. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.2 SOURCE QUALITY CONTROL

A. Test motors in accordance with NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

PART 3 EXECUTION

3.1 EXISTING WORK

A. Disconnect and remove abandoned motors

B. Maintain access to existing motors and other installations remaining active and requiring access. Modify installation or provide access panel.

C. Clean and repair existing motors to remain or are to be reinstalled.

3.2 INSTALLATION

A. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

B. Install engraved plastic nameplates in accordance with Section 260553.

C. Ground and bond motors in accordance with Section 260526.

3.3 FIELD QUALITY CONTROL

A. Division 1 - Execution Requirements: Testing, adjusting, and balancing.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.15.

END OF SECTION 262810

SECTION 262813 - FUSES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fuses.
   2. Spare fuse cabinet.

B. RELATED SECTIONS
   1. Division 9 - Painting: Painting of spare fuse cabinet.

1.2 REFERENCES

A. NFPA 70 - National Electric Code.

B. NEMA FU 1 - Low Voltage Cartridge Fuses.

1.3 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data: Provide data sheets showing electrical characteristics including time-current curves.

1.4 PROJECT RECORD DOCUMENTS

A. Record actual fuse sizes.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this section.

1.6 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by UL.

1.7 MAINTENANCE MATERIALS

A. Provide one fuse puller.

1.8 EXTRA MATERIALS

A. Provide three extra of each size and type fuse installed.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Bussmann

B. Gould Shawmut

C. Littlefuse, Inc.

2.2 FUSE REQUIREMENTS

A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.

B. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.

C. Main Service Switches: N/A.

D. Power Load Feeder Switches: Class RK5 time delay.

E. Motor Load Feeder Switches: Class RK5 time delay.

F. Other Feeder Switches: Class RK5 time delay.

G. Motor Branch Circuits: Class RK5 time delay.

2.3 CLASS RK1 (TIME DELAY) FUSES

A. Manufacturers:
1. Bussman Model LPS.
2. Equal by Gould Shawmut
3. Equal by Littlefuse, Inc.

2.4 CLASS RK5 (TIME DELAY) FUSES

A. Manufacturers:
1. Bussmann Model FRS-R (FRN-R for 250 volts).
2. Equal by Gould Shawmut.
3. Equal by Littlefuse, Inc.

2.5 SPARE FUSE CABINET

A. Description: Wall-mounted sheet metal cabinet, suitably sized to store spare fuses and fuse pullers specified. Pre-finished or field painted by E.C.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install fuses in accordance with manufacturer's instructions.

B. Install fuse with label oriented such that manufacturer, type, and size are easily read.

C. Install spare fuse cabinet in the main electrical room.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
   1. fusible switches
   2. nonfusible switches.

B. Related Sections:
   1. Section 262813 - Fuses.

1.2 REFERENCES

A. NEMA KS 1 - Enclosed Switches.

B. NFPA 70 - National Electrical Code.

C. UL 198C - High-Interrupting Capacity Fuses; Current Limiting Type.

D. UL 198E - Class R Fuses.

1.3 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data: Provide switch ratings and enclosure dimensions.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with NECA Standard of Installation.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this Section.

1.6 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by UL.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Cutler Hammer Series DH.

B. Equal by Square D.

C. Equal by GE.

2.2 ENCLOSED SWITCHES

A. Fusible Switch Assemblies: NEMA KS 1, Type Heavy Duty (HD) load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse clips: Designed to accommodate Class R fuses.

B. Nonfusible Switch Assemblies: NEMA KS 1, Type HD load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

C. Enclosures: NEMA KS 1.
   1. Interior Dry Locations: Type 1.
   2. Exterior and wet Locations: Type 3R.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in fusible disconnect switches and fused combination motor starters.

B. Provide adhesive label on inside door of each switch indicating UL fuse class and size for replacement.

END OF SECTION 262816

SECTION 263213 - ENGINE GENERATOR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged engine-generator sets suitable for use in applications with the features as specified and indicated where the engine generators will be used as the Standby power source for the system.

1.3 DEFINITIONS

A. Emergency Standby Power (ESP): Per ISO 8528: The maximum power available during a variable electrical power sequence, under the stated operating conditions, for which a generating set is capable of delivering in the event of a utility power outage or under test conditions for up to 200 hours of operation per year with the maintenance intervals and procedures being carried out as prescribed by the manufacturers. The permissible average power output (Ppp) over 24 hours of operation shall not exceed 70 percent of the ESP unless otherwise agreed by the RIC engine manufacturer.

B. Prime Power (PRP): Per ISO 8528: The maximum power which a generating set is capable of delivering continuously whilst supplying a variable electrical load when operated for an unlimited number of hours per year under the agreed operating conditions with the maintenance intervals and procedures being carried out as a prescribed by the manufacturer. The permissible average power output (Ppp) over 24 hours of operation shall not exceed 70 percent of the PRP unless otherwise agreed by the RIC engine manufacturer.

C. Limited Time running Power (LTP): Per ISO 8528: The maximum power available, under the agreed operating conditions, for which the generating set is capable of delivering for up to 500 hours of operation per year with the maintenance intervals and procedures being carried out as prescribed by the manufacturers.

D. Continuous Operating Power (COP): Per ISO 8528: The maximum power which a generating set is capable of delivering continuously whilst supplying a constant electrical load when operated for an unlimited number of hours per year under the agreed operating conditions with the maintenance intervals and procedures being carried out as a prescribed by the manufacturer.

E. Data Center Continuous (DCC): The maximum power which a generating set is capable of delivering continuously whilst supplying a variable or constant electrical load when operated for an unlimited number of hours in a data center application under the agreed operating conditions with the maintenance intervals and procedures being carried out as a prescribed

by the manufacturer. The permissible average power output (Ppp) over 24 hours of operation shall not exceed 100 percent of the DCC rating.

F. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Thermal damage curve for generator.

2. Time-current characteristic curves for generator protective device.

3. Sound test data, based on a free field requirement.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.

2. Wiring Diagrams: Control interconnection, Customer connections.

C. Certifications:

1. Submit statement of compliance which states the proposed product(s) is certified to the emissions standards required by the location for No Preference.

1.5 INFORMATIONAL SUBMITTALS

A. Source quality-control test reports.

1. Certified summary of prototype-unit test report. See requirements in Part 2 "Source Quality Control" Article Part A. Include statement indicating torsional compatibility of components.

2. Certified Test Report: Provide certified test report documenting factory test per the requirements of this specification, as well as certified factory test of generator set sensors per NFPA110 level 1.

3. List of factory tests to be performed on units to be shipped for this Project.

4. Report of exhaust emissions and compliance statement certifying compliance with applicable regulations.

B. Warranty:

1. Submit manufacturer’s warranty statement to be provided for this Project.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within city of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

D. Comply with NFPA 37 (Standard For the Installation and Use of Stationary Combustion Engines and Gas Turbines).

E. Comply with NFPA 70 (National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702).

F. Comply with NFPA 110 (Emergency and Standby Power Systems) requirements for Level 1 emergency power supply system.

1.7 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 0.0 deg C (32.0 deg F) to 32.22 deg C (90.0 deg F).

2. Relative Humidity: 0 to 95 percent.

3. Altitude: Sea level

1.8 WARRANTY

A. Base Warranty: Manufacturer shall provide base warranty coverage on the material and workmanship of the generator set for a minimum of twenty-four (24) months for Standby product and twelve (12) months for Prime/Continuous product from registered commissioning and start-up.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: The basis for this specification is Cummins Power Generation equipment, approved equals may be considered if equipment performance is shown to meet the requirements herein.

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

1. Rigging Information: Indicate location of each lifting attachment, generator-set center of gravity, and total package weight in submittal drawings.

C. Capacities and Characteristics:

1. Power Output Ratings: Electrical output power rating for Standby operation of not less than 250.0kW, at 80 percent lagging power factor

D. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 0.5 percent of rated output voltage from no load to full load.

2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 5 seconds. On application of a 100% load step the generator set shall recover to stable voltage within 10 seconds.

3. Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.

4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

5. Transient Frequency Performance: Not more than 15 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 5 seconds. On application of a 100% load step the generator set shall recover to stable frequency within 10 seconds.

6. Output Waveform: At full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.

7. Sustained Short-Circuit Current: (For engine-generator sets using a PMG-excited alternator) For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 8 seconds without damage to generator system components. For a 1-phase, bolted short circuit at system output terminals, system shall regulate both voltage and current to prevent over-voltage conditions on the non-faulted phases.

8. Start Time: Comply with NFPA 110, Level 1, Type 10, system requirements.

9. Ambient Condition Performance: Engine generator shall be designed to allow operation at full rated load in an ambient temperature under site conditions, based on highest ambient condition. Ambient temperature shall be as measured at the air inlet to the engine generator for enclosed units, and at the control of the engine generator for machines installed in equipment rooms.

2.3 ENGINE

A. Fuel: ASTM D975 #2 Diesel Fuel

B. Rated Engine Speed: 1800RPM.

C. Lubrication System: The following items are mounted on engine or skid:

1. Lube oil pump: shall be positive displacement, mechanical, full pressure pump.

2. Filter and Strainer: Provided by the engine manufacturer of record to provide adequate filtration for the prime mover to be used.

3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Engine Fuel System: The engine fuel system shall be installed in strict compliance to the engine manufacturer's instructions

E. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.

F. Governor: Adjustable isochronous, with speed sensing. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.

G. Cooling System: Closed loop, liquid cooled

1. The generator set manufacturer shall provide prototype test data for the specific hardware proposed demonstrating that the machine will operate at rated standby load in an outdoor ambient condition of 40 deg C.

2. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

3. Size of Radiator overflow tank: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.

4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.

5. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

6. Duct Flange: Generator sets installed indoors shall be provided with a flexible radiator duct adapter flange.

H. Muffler/Silencer: Selected with performance as required to meet sound requirements of the application, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements. For generator sets with outdoor enclosures the silencer shall be inside the enclosure.

I. Air-Intake Filter: Engine-mounted air cleaner with replaceable dry-filter element and restriction indicator.

J. Starting System: 12 or 24V, as recommended by the engine manufacturer; electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.

2. Cranking Cycle: As required by NFPA 110 for level 1 systems.

3. Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.

4. Battery Compartment: Factory fabricated of metal with acid-resistant finish.

5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation. The battery charging alternator shall have sufficient capacity to recharge the batteries with all parasitic loads connected within 4 hours after a normal engine starting sequence.

6. Battery Chargers: Unit shall comply with UL 1236, provide fully regulated, constant voltage, current limited, battery charger for each battery bank. It will include the following features:

a. Operation: Equalizing-charging rate based on generator set manufacturer’s recommendations shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.

b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 20 deg C to plus 40 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.

c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.

d. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

e. Provide LED indication of general charger condition, including charging, faults, and modes. Provide a LCD display to indicate charge rate and battery voltage. Charger shall provide relay contacts for fault conditions as required by NFPA110.

f. Enclosure and Mounting: NEMA, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Sub Base-Mounted Fuel Oil Tank: Provide a double wall secondary containment type sub base fuel storage tank. The tank shall be constructed of corrosion resistant steel and shall be listed and labeled. The fuel tank shall include the following features:

1. Capacity: Fuel for 24 Hour(s) continuous operation at 100 percent rated power output.

2. Tank rails and lifting eyes shall be rated for the full dry weight of the tank, genset, and enclosure.

3. Electrical stub up(s)

4. Normal & emergency vents

5. Lockable fuel fill

6. Mechanical fuel level gauge

7. High and low level switches to indicate fuel level

8. Leak detector switch

9. Sub base tank shall include a welded steel containment basin, sized at a minimum of 110% of the tank capacity to prevent escape of fuel into the environment in the event of a tank rupture.

10. Fill port with overfill prevention valve (OFPV)

11. 5 gallon fill/spill dam or bucket

12. Tank design shall meet the regional requirements for the Project location

2.5 CONTROL AND MONITORING

A. Engine generator control shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit.

B. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. (Switches with different configurations but equal functions are acceptable.) When generator set is running, specified system or equip-

ment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.

C. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.

D. Configuration: Operating and safety indications, protective devices, system controls, engine gages and associated equipment shall be grouped in a common control and monitoring panel. Mounting method shall isolate the control panel from generator-set vibration. AC output power circuit breakers and other output power equipment shall not be mounted in the control enclosure.

E. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:

1. AC voltmeter (3-phase, line to line and line to neutral values).
2. AC ammeter (3-phases).
3. AC frequency meter.
4. Ammeter-voltmeter displays shall simultaneously display conditions for all three phases.
5. Emergency Stop Switch: Switch shall be a red “mushroom head” pushbutton device complete with lock-out/tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating.
6. Fault Reset Switch: Supply a dedicated control switch to reset/clear fault conditions.
7. DC voltmeter (alternator battery charging).
8. Engine-coolant temperature gauge.
9. Engine lubricating-oil pressure gauge.
10. Running-time meter.
11. Generator-voltage and frequency digital raise/lower switches. Rheostats for these functions are not acceptable. The control shall adjustment of these parameters in a range of plus or minus 5% of the voltage and frequency operating set point (not nominal voltage and frequency values.) The voltage and frequency adjustment functions shall be disabled when the paralleling breaker is closed.
12. Fuel tank derangement alarm.
13. Fuel tank high-level shutdown of fuel supply alarm.

14. AC Protective Equipment: The control system shall include over/under voltage, reverse kVAR over current, loss of voltage reference, and over excitation shut down protection. There shall be a overload warning, and overcurrent warning alarm.

15. Status LED indicating lamps to indicate remote start signal present at the control, existing shutdown condition, existing alarm condition, not in auto, and generator set running.

16. A graphical display panel with appropriate navigation devices shall be provided to view all information noted above, as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall also include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.

17. Panel lighting system to allow viewing and operation of the control when the generator room or enclosure is not lighted.

18. Data Logging: The control system shall log the latest 20 different alarm and shut down conditions, the total number of times each alarm or shutdown has occurred, and the date and time the latest of these shutdown and fault conditions occurred.

19. DC control Power Monitoring: The control system shall continuously monitor DC power supply to the control, and annunciate low or high voltage conditions. It shall also provide an alarm indicating imminent failure of the battery bank based on degraded voltage recover on loading (engine cranking).

F. Remote Alarm Annunciator: Comply with NFPA 110. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition.

2.6 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H

D. Temperature Rise: 80 / Class B environment.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over speed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Shunt Excitation

G. Enclosure: Drip-proof.

H. Voltage Regulator: SCR type, Separate from exciter, providing performance as specified. The voltage regulation system shall be microprocessor-controlled, full wave rectified, and provide a pulse-width modulated signal to the exciter. No exceptions or deviations to these requirements will be permitted.

I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

J. Subtransient Reactance: 15 percent maximum, based on the rating of the engine generator set.

2.7 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Weather Aluminum housing. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Instruments, control, and battery system shall be mounted within enclosure.

B. Construction:

1. Hinged Doors: With padlocking provisions. Restraint/Hold back hardware to prevent door to keep door open at 180 degrees during maintenance. Rain lips over all doors.

2. Exhaust System:

a. Muffler Location: Within enclosure.

3. Hardware: All hardware and hinges shall be stainless steel.

4. Mounting Base: Suitable for mounting on sub-base fuel tank or housekeeping pad.

5. A weather protective enclosure shall be provided which allows the generator set to operate at full rated load with a static pressure drop equal to or less than 0.5 inches of water.

C. Engine Cooling Airflow through Enclosure: Housing shall provide ample airflow for engine generator operation at rated load in an ambient temperature of 40 deg C.

1. Louvers: Fixed-engine, cooling-air inlet and discharge.

D. Sound Performance: Reduce the sound level of the engine generator while operating at full rated load to a maximum of 10 dBA measured at any location 7 m from the engine generator in a free field environment.

E. Site Provisions:

1. Lifting: Complete assembly of engine generator, enclosure, and sub base fuel tank (when used) shall be designed to be lifted into place as a single unit, using spreader bars.

2.8 VIBRATION ISOLATION DEVICES

A. Vibration Isolation: Generators installed on grade shall be provided with elastomeric isolator pads integral to the generator, unless the engine manufacturer requires use of spring isolation.

2.9 FINISHES

A. Indoor and Outdoor Enclosures and Components: Powder-coated and baked over corrosion-resistant pretreatment and compatible primer. Manufacturer's standard color or as directed on the drawings.

2.10 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters. In addition, the equipment engine, skid, cooling system, and alternator shall have been subjected to actual prototype tests to validate the capability of the design under the abnormal conditions noted in NFPA110. Calculations and testing on similar equipment which are allowed under NFPA110 are not sufficient to meet this requirement.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test engine generator set manufactured for this Project to demonstrate compatibility and functionality.

2. Full load run.

3. Maximum power.

4. Voltage regulation.

5. Steady-state governing.

6. Single-step load pickup.

7. Simulated safety shutdowns.

8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.

9. [Additional testing requirements may be added to this section]

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation, application, and alignment instructions and with NFPA 110.

B. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.

C. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.

D. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.

E. Equipment shall be initially started and operated by representatives of the manufacturer. All protective settings shall be adjusted as instructed by the consulting engineer.

F. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.

G. On completion of the installation by the electrical contractor, the generator set supplier shall conduct a site evaluation to verify that the equipment is installed per manufacturer's recommended practice.

3.2 ON-SITE ACCEPTANCE TEST

A. The complete installation shall be tested to verify compliance with the performance requirements of this specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests. The generator set manufacturer shall provide a site test specification covering the entire system. Tests shall include:

B. Prior to start of active testing, all field connections for wiring, power conductors, and bus bar connections shall be checked for proper tightening torque.

C. Installation acceptance tests to be conducted on site shall include a "cold start" test, a two hour full load (resistive) test, and a one-step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.

D. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

3.4 SERVICE AND SUPPORT

A. The generator set supplier shall maintain service parts inventory for the entire power system at a central location which is accessible to the service location 24 hours per day, 365 days per year. The inventory shall have a commercial value of $3 million or more. The manufacturer of the generator set shall maintain a central parts inventory to support the supplier, cov-

ering all the major components of the power system, including engines, alternators, control systems, paralleling electronics, and power transfer equipment.

B. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical power system replacement parts in the local service location. Service vehicles shall be stocked with critical replacement parts. The service organization shall be on call 24 hours per day, 365 days per year. The service organization shall be physically located within pgh of the site.

C. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

END OF SECTION 263213

SECTION 263600 - TRANSFER SWITCHES

AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches

2. Bypass/isolation switches

3. Remote annunciation systems

B. Related Sections include the following:

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

1. Technical data on all major components of all transfer switches and other products described in this section. Data is required for the transfer switch mechanism, control system, cabinet, and protective devices specifically listed for use with each transfer switch. Include steady state and fault current ratings, weights, operating characteristics, and furnished specialties and accessories.

2. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Dimensioned outline drawings of assembly, including elevations, sections, and details including minimal clearances, conductor entry provisions, gutter space, installed features and devices and material lists for each switch specified.

2. Internal electrical wiring and control drawings.

3. Interconnection wiring diagrams, showing recommended conduit runs and point-to-point terminal connections to generator set.

4. Installation and mounting instructions, including information for proper installation of equipment to meet seismic requirements.

C. Manufacturer and Supplier Qualification Data

1. The transfer switch manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

2. The manufacturer of this equipment shall have produced similar equipment for a minimum period of 10 years. When requested, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Features and operating sequences, both automatic and manual.

2. List of all factory settings of relays, timers and protective devices; provide setting and calibration instructions where applicable.

E. Warranty documents demonstrating compliance with the project's contract requirements.

1.4 QUALITY ASSURANCE

A. Only approved bidders shall supply equipment provided under this contract.

B. Manufacturer Qualifications: The equipment supplier shall maintain a service center capable of providing training, parts, maintenance and emergency repairs to equipment, including transfer switch generator sets and remote monitoring equipment (if applicable) at the site within a response period of less than (eight hours or appropriate time period designated for Project) from time of notification.

1. The transfer switch shall be serviced by technicians employed by, and specially trained and certified by, the generator set supplier and the supplier shall have a service organization that is factory-certified in both generator set and transfer switch service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

2. Submit names, experience level, training certifications, and locations for technicians that will be responsible for servicing equipment at this site.

3. The manufacturer shall maintain model and serial number records of each transfer switch provided for at least 20 years.

C. Source Limitations: All transfer switches are to be obtained through one source from a single manufacturer. The generator set manufacturer shall warrant transfer switches to provide a single source of responsibility for products provided.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked as suitable for use in emergency, legally required or optional standby use as appropriate for the connected load.

E. The automatic transfer switch installation and application shall conform to the requirements of the following codes and standards:

1. Transfer switches and enclosures shall be UL 1008 listed and labeled as suitable for use in emergency, legally required, and optional standby applications.

2. CSA 282, Emergency Electrical Power Supply for Buildings, and CSA C22.2, No. 14-M91 Industrial Control Equipment

3. NFPA 70, National Electrical Code. Equipment shall be suitable for use in systems in compliance with Articles 700, 701 and 702.

4. Comply with NEMA ICS 10-1993 AC Automatic Transfer Switches

5. IEEE 446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

6. EN55011, Class B Radiated Emissions and Class B Conducted Emissions

7. IEC 1000-4-5 (EN 61000-4-5); AC Surge Immunity

8. IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity

9. IEC 1000-4-2 (EN 61000-4-2) Electrostatic Discharge Immunity

10. IEC 1000-4-3 (EN 61000-4-3) Radiated Field Immunity

11. IEC 1000-4-6 Conducted Field Immunity

12. IEC 1000-4-11 Voltage Dip Immunity

13. IEEE 62.41, AC Voltage Surge Immunity

14. IEEE 62.45, AC Voltage Surge Testing

F. Comply with NFPA 99 – Essential Electrical Systems for Healthcare Facilities

G. Comply with NFPA 110 – Emergency and Standby Power Systems. The transfer switch shall meet all requirements for Level 1 systems, regardless of the actual circuit level.

H. The manufacturer shall warrant the material and workmanship of the transfer switch equipment for a minimum of two (2) year from the warranty start date. The warranty start date is the date of registered commissioning and start up or eighteen (18) months from date of shipment, whichever is sooner.

I. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, and etc. during the minimum noted warranty period described above.

1.5 PROJECT CONDITIONS

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

1. Notify (Architect/Construction Manager/Owner) no fewer than (insert appropriate number) days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without (Architect/Construction Manager/Owner's) written permission.

3. Do not energize any new service or distribution equipment without notification and permission of the (Architect/Construction Manager/Owner).

1.6 COORDINATION

A. Size and location of concrete bases and anchor bolt inserts shall be coordinated. Concrete, reinforcement and formwork must meet the requirements specified in Division 03. See section "INSTALLATION" for additional information on installation

B. If Project calls for bypass switch(es) mounted on a concrete base, the base must be designed to accommodate the requirements of the drawout mechanism (extension rails and/or wheeled carriage) of the bypass switch.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cummins Power Generation

B. Equipment specifications for this Project are based on automatic transfer switches manufactured by Cummins Power Generation. Switches manufactured by other manufacturers that meet the requirement of this specification are acceptable, if approved not less than two weeks before scheduled bid date. Proposals must include a line-by-line compliance statement based on this specification.

C. Transfer switches utilizing molded case circuit breakers do not meet the requirements of this specification and will not be accepted.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Provide transfer switches in the number and ratings that are shown on the drawings.

B. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer.

C. Fault-Current Closing and Withstand Ratings: UL 1008 WCR ratings must be specifically listed as meeting the requirements for use with protective devices at installation locations,

under specified fault conditions. Withstand and closing ratings shall be based on use of the same set of contacts for the withstand test and the closing test.

D. Solid-State Controls: All settings should be accurate to +/- 2% or better over an operating temperature range of - 40 to + 60 degrees C (- 40 to + 140 degrees F).

E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

F. Electrical Operation: Accomplished by a non-fused, momentarily energized solenoid or electric motor operator mechanism, mechanically and electrically interlocked in both directions (except that mechanical interlock is not required for closed transition switches).

G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Switches using molded-case switches or circuit breakers, or insulated case circuit breaker components are not acceptable.

2. Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in the Source 1 and Source 2 positions.

3. Main switch contacts shall be high pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.

4. Contacts shall be operated by a high-speed electrical mechanism that causes contacts to open or close within three electrical cycles from signal.

5. The power transfer mechanism shall include provisions for manual operation under load with the enclosure door closed. Manual operation may be electromechanical or mechanical, but must be coordinated with control function.

6. Transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation but prevent direct contact with components that could be operating at line voltage levels.

7. The transfer switch shall include the mechanical and control provisions necessary to allow the device to be field-configured for operating speed. Transfer switch operation with motor loads shall be as is recommended in NEMA MG1.

    a. Phase angle monitoring/timing equipment is not an acceptable substitute for this functionality

8. Transfer switches designated on the drawings as “4-pole” shall be provided with a switched neutral pole switched which is switched simultaneously with phase poles.

9. Transfer switches designated on the drawings as "isolation-bypass" switches shall meet the requirements of section "BYPASS/ISOLATION SWITCHES" of this specification.

H. Control: Transfer switch control shall be capable of communicating with the genset control, other switches and remote programming devices over a high-speed network interface.

I. Factory wiring: Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism

J. Terminals: Terminals shall be pressure type and appropriate for all field wiring. Control wiring shall be equipped with suitable lugs, for connection to terminal strips.

K. Enclosures: All enclosures shall be third-party certified for compliance to NEMA ICS 6 and UL 508, unless otherwise indicated:

1. The enclosure shall provide wire bend space in compliance to the latest version of NFPA70, regardless of the direction from which the conduit enters the enclosure.

2. Exterior cabinet doors shall provide complete protection for the system's internal components. Doors must have permanently mounted key-type latches. Bolted covers or doors are not acceptable.

3. Transfer switches shall be provided in enclosures that are third party certified for their intended environment per NEMA requirements.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with requirements for Level 1 equipment according to NFPA 110.

B. Indicated current ratings:

1. Refer to the Project drawings for specifications on the sizes and types of transfer switch equipment, withstand and closing ratings, number of poles, voltage and ampere ratings, enclosure type, and accessories.

2. Main contacts shall be rated for 600 VAC minimum.

3. Transfer switches shall be rated to carry 100% of rated current continuously in the enclosure supplied, in ambient temperatures of -40 to +60 degrees C (-40 to +140 degrees F), relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000 meters).

C. Manual Switch Operation: The power transfer mechanism shall include provisions for manual operation under load with the enclosure door closed. Manual operation may be electromechanical or mechanical, but must be coordinated with control function

D. Relay Signal: Control shall include provisions for addition of a pre-transfer relay signal, adjustable from 0 to 60 seconds, to be provided if necessary for elevator operation, based on equipment provided for the project.

E. Control: Transfer switch control shall be provided with necessary equipment and software to communicate with the genset control, other transfer switches, remote annunciation equipment, and other devices over a high speed control network.

F. Neutral Switching: Transfer switches designated on the drawings as 4-pole shall be provided with a switched neutral pole. The neutral pole shall be of the same construction and have the same ratings as the phase poles. All poles shall be switched simultaneously using a common crossbar. Substitute equipment using overlapping neutral contacts is not acceptable.

G. The transfer switch physically located closest to the generator and not more than 50 ft (15 meters) away, except those served by generator paralleling equipment, shall be provided with a battery charger suitable for the requirements of the application and in compliance with NFPA 110 requirements for Level 1 systems. If no transfer switch is located within this distance, a battery charger shall be installed on the generator set.

H. Automatic Transfer Switch Control Features

1. The transfer switch control system shall be configurable in the field for any operating voltage level up to 600 VAC. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions that are not field configurable are not acceptable.

2. All transfer switch sensing shall be configurable from an operator panel or from a Windows XP or later PC-based service tool. Designs utilizing DIP switches or other electromechanical devices are not acceptable.

3. The transfer switch shall provide a relay contact signal prior to transfer or re-transfer. The time period before and after transfer shall be adjustable in a range of 0 to 60 seconds.

4. The control system shall be designed and prototype tested for operation in ambient temperatures from - 40 degrees C to + 60 degrees C (- 40 to +140 degrees F). It shall be designed and tested to comply with the requirements of the noted voltage and RFI/EMI standards.

5. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.

6. The transfer switch network monitoring equipment, when supplied, shall be provided with a battery-based auxiliary power supply to allow monitoring of the transfer switch when both AC power sources are non-operational.

7. The indicator panel LEDs shall display:

a. Which source the load is connected to (Source 1 or Source 2)

b. Which source or sources are available

c. When switch is not set for automatic operation, the control is disabled or the bypass switch is in use

d. When the switch is in test/exercise mode

8. The indicator shall have pushbuttons that allow the operator to activate the following functions:

    a. Activate pre-programmed test sequence

    b. Override programmed delays, and immediately go to the next operation

    c. Reset the control by clearing any faults

    d. Test all of the LEDs by lighting them simultaneously

9. The alphanumeric digital display shall be vacuum fluorescent-type, clearly visible in both bright sunlight and no-light conditions over an angle of 120 degrees, and shall display the following:

    a. AC voltage for all phases, normal and emergency

    b. Source status: connected or not connected.

10. The display panel shall be password-protected, and allow the operator to view and make adjustments:

    a. Set nominal voltage and frequency for the transfer switch

    b. Adjust voltage and frequency sensor operation set points

    c. Set up time clock functions

    d. Set up load sequence functions

    e. Enable or disable control functions including program transition

    f. View real-time clock data, operation log (hours connected, times transferred, failures) and service history

I. Transfer Switch Control Panel: The transfer switch shall have a microprocessor-based control with a sealed membrane panel incorporating pushbuttons for operator-controlled functions, and LED lamps for system status indicators. Panel display and indicating lamps shall include permanent labels.

J. Control Functions: Functions managed by the control shall include:

1. Software adjustable time delays:

    a. Engine start (prevents nuisance genset starts in the event of momentary power fluctuation): 0 to 120 seconds (default 3 sec)

    b. Transfer normal to emergency (allows genset to stabilize before load is transferred): 0 to 120 seconds (default 3 sec)

    c. Re-transfer emergency to normal (allows utility to stabilize before load is transferred from genset): 0 to 30 minutes (default 3 sec)

d. Engine cooldown: 0 to 30 minutes (default 10 min)

e. Programmed transition: 0 to 60 seconds (default 3 sec)

2. Undervoltage sensing: three-phase normal, three-phase emergency source.

3. Over-voltage sensing: three-phase normal, three-phase emergency source.

4. Over/under frequency sensing:

a. Pickup: +/- 5 to +/-20% of nominal frequency (default 10%)

b. Dropout: +/-1% beyond pickup (default 1%)

c. Dropout time delay: 0.1 to 15.0 seconds (default 5 sec)

d. Accurate to within +/- 0.05 Hz

5. Voltage imbalance sensing:

a. Dropout: 2 to 10% (default 4%)

b. Pickup: 90% of dropout

c. Time delay: 2.0 to 20 seconds (default 5 sec)

6. Phase rotation sensing:

a. Time delay: 100 msec

7. Loss of single-phase detection:

a. Time delay: 100 msec

K. Control features shall include:

1. Programmable genset exerciser: A field-programmable control shall periodically start and run the generator with or without transferring the load for a preset time period, then re-transfer and shut down the generator after a preset cool-down period.

2. In event of a loss of power to the control, all control settings, real-time clock setting and the engine start-time delay setting will be retained.

3. The system continuously logs information including the number of hours each source has been connected to the load, the number of times transferred, and the total number of times each source has failed. An event recorder stores information, including time and date-stamp, for up to 50 events.

4. Re-Transfer Inhibit Switch: Inhibits automatic re-transfer control so automatic transfer switch will remain connected to emergency power source as long as it is available regardless of condition of normal source.

5. Transfer Inhibit Switch: Inhibits automatic transfer control so automatic transfer switch will remain connected to normal power source regardless of condition of emergency source.

L. Control Interface

1. Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.

2. Unassigned Auxiliary Contacts: Two normally open, 1-pole, double-throw contacts for each switch position, rated 10A at 240 VAC.

M. Engine Starting Contacts

1. One isolated and normally closed pair of contacts rated 10A at 32 VDC minimum.

2.4 BYPASS/ISOLATION SWITCHES

A. Comply with requirements for Level 1 equipment according to NFPA 110.

B. Description: Transfer switches that are designated on the drawings as “bypass isolation” transfer switches shall be provided with a manually-operated bypass switch arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:

1. The bypass switch shall be enclosed in the same cabinet as the automatic transfer switch, and UL-listed as an assembled product.

2. The bypass isolation switch shall provide a means for manually bypassing the transfer switch from either source (Normal or Emergency) to the load, while under load if necessary, and to isolate the transfer switch from both sources for maintenance or repair without a power interruption or disturbance.

a. Designs that bypass to only one source are not acceptable under this specification.

3. The bypass switch shall be operable without the use of tools, and shall include the ability to isolate the automatic switch mechanism without the use of tools and without opening the exterior cabinet door(s).

4. Operability: Switch shall be constructed so load bypass and transfer-switch isolation can be performed by one person in no more than two operations, in 15 seconds or less.

5. Bypass isolation switch equipment shall be UL listed per Standard 1008 and CSA approved, with continuous current rating, voltage and frequency ratings, and withstand and closing ratings equal to the transfer switch ratings at the specified conditions of ambient temperature, humidity, and altitude.

6. The bypass isolation and transfer switches shall be mechanically held in each position. Switching mechanisms shall be break-before-make on all poles, including the neutral pole on 4-pole switches except where closed transition transfer is specified as defined in section "CLOSED-TRANSITION TRANSFER SWITCHES". The switch mechanism shall be an over-center toggle device which provides stored energy contact operation during both opening and closing. The speed of contact operation shall be independent of the force applied to the operating handles, which permit manual operation under load.

7. Provide means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. While isolated, interlocks shall prevent transfer-switch operation, except for testing or maintenance.

8. Bypass switch shall be a fully-rated, manually-operated switch, rated for the same loads as the automatic transfer switch. Bypass switch shall provide bypass to either normal or emergency source by use of a door mounted, keyed source selector switch and a permanently mounted external operating handle. Equipment shall provide manual bypass without disturbance of the power supply to the load.

    a. Equipment requiring load isolation before bypass is not acceptable for use on this Project.

9. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.

10. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.

11. Positive mechanical interlocks shall prevent all possible source-to-source interconnections via the bypass switch. The interlock system shall assure a properly sequenced, mechanically guided bypass and isolation action.

    a. Designs which depend on electrical interlocks to prevent source to source interconnections, or which intentionally interconnect the sources via the bypass switch, are not acceptable.

12. The equipment shall utilize automatic, mechanical stops to prevent manually bypassing to a dead source.

    a. Equipment that does not prevent dead source bypass is not acceptable.

13. A drawout isolation mechanism shall provide closed-door isolation of the transfer switch. The isolation mechanism shall be interlocked so that either the transfer switch must be bypassed or the transfer switch must be open before the mechanism will permit isolation of the transfer switch. Drawout arrangement must provide physical separation from live parts and accessibility for testing and maintenance operations.

14. The isolation mechanism shall provide for three-position operation: Connected, Test, and Isolated. In the Connected position, isolation contacts shall be fully engaged and closed, with the transfer switch control cable connected. In the Test position, isolation contacts shall be open and the transfer switch control cable connected. The Test position shall allow operational testing of transfer switchs and controls without power disruption to the load. In the Isolated position, the transfer switch and control shall be completely isolated from all power sources. In the Isolated position, the transfer switch shall be capable of being withdrawn from the cabinet.

15. The bypass and isolation process for the automatic transfer switch shall be capable of being fully accomplished without opening the cabinet door.

16. Interconnection of bypass/isolation switch with automatic transfer switch shall consist of factory-installed copper bus bars, plated at connection points and braced for the indicated available short-circuit current.

17. Note the size and access requirements for the transfer switch with bypass isolation and provide equipment that will fit into the space allowed as well as complying with code-specified access requirements.

18. Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.

C. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars, plated at connection points and braced for the indicated available short-circuit current.

2.5 REMOTE ANNUNCIATOR SYSTEM

A. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:

1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.

2. Switch position.

3. Switch in test mode.

4. Failure of communication link.

B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

1. Indicating Lights: Grouped for each transfer switch monitored.

2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.

3. Switch in test mode.

4. Lamp Test: Push-to-test or lamp-test switch on front panel.

C. Malfunction of annunciator or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically reverts to stand-alone, self-contained operation.

D. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation. The remote annunciation system shall not prevent transfer to the alternate source when the primary power source fails, nor prevent return to the primary source if the alternate source fails

PART 3 - EXECUTION

3.1 INSTALLATION

A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Floor-Mounting Switch: Anchor to floor by bolting.

1. Floor-mounted transfer switches (except drawout switches supported by wheeled carriages, which must be rolled out at floor level) shall be mounted on concrete bases complying with the following requirements:

a. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

C. Annunciator Panel Mounting: Flush in wall, unless otherwise indicated.

D. Identify components according to Division 26 Section "Identification for Electrical Systems."

E. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.

C. Transfer switch shall be provided with AL/CU mechanical lugs sized to accept the full output rating of the switch. Lugs shall be suitable for the number and size of conductors shown on the drawings.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 SOURCE QUALITY CONTROL

A. Prior to shipping, factory shall test and inspect components, assembled switches, and associated equipment to ensure proper operation.

B. Factory shall check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements.

C. Factory shall perform dielectric strength test complying with NEMA ICS 1.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: The supplier of the transfer switch(es) and associated equipment shall inspect, test, and adjust components, assemblies, and equipment installations, including connections, and report results in writing.

B. Manufacturer’s representative shall perform tests and inspections and prepare test reports.

C. After installing equipment and after electrical circuitry has been energized, installer shall test for compliance with requirements.

1. Perform recommended installation tests as recommended in manufacturer’s installation and service manuals.

2. After energizing circuits, demonstrate interlocking sequence and operational function for each switch.

a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.

b. Verify time-delay settings.

c. Verify that the transfer switch is accurately metering AC voltage.

d. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.

e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 DEMONSTRATION

A. After generator set installation, the generator and transfer switch supplier shall conduct a complete operation, basic maintenance, and emergency service seminar covering generator set and transfer switch equipment, for up to 10 people employed by the Owner.

1. The seminar shall include instruction on operation of the transfer equipment, normal testing and exercise, adjustments to the control system, use of the PC based service and maintenance tools provided under this contract, and emergency operation procedures.

2. The class duration shall be at least 8 hours in length, and include practical operation with the installed equipment.

3.6 SERVICE AND SUPPORT

A. The manufacturer shall supply the Service Provider with a complete set of the service and maintenance software required to support the product. The software shall be provided at a training class attended by the user, to qualify the user in proper use of the software. The software shall have the following features and capabilities:

1. The software shall allow adjustment of all functions described herein, adjustment of operating levels of all protective functions, and programming of all optional functions in the controller. Adjustments shall be possible over modem from a facility that is remote from the generator set.

2. The software shall be capable of storing and displaying data for any function monitored by the generator set control. This data shall be available in common file formats, and on graphical “strip chart” displays.

3. The software shall automatically record all control operations and adjustments performed by any operator or software user, for tracking of changes to the control.

4. The software shall display all warning, shutdown, and status changes programmed into transfer switch controller. For each event, the control shall provide information on the nature of the event, when it last occurred, and how many times it has occurred.

END OF SECTION 263600

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

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 lightning protection system for ordinary structures.

B. Section includes lightning protection system for the following:

1. Ordinary structures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layouts of the lightning protection system, with details of the components to be used in the installation.
2. Include raceway locations needed for the installation of conductors.
3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
4. Include roof attachment details, coordinated with roof installation.
5. Calculations required by NFPA 780 for bonding of metal bodies.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Lightning protection system Shop Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Lightning protection cabling attachments to roofing systems and accessories.
2. Lightning protection strike termination device attachment to roofing systems, coordinated with the roofing system manufacturer.
3. Lightning protection system components penetrating roofing and moisture protection systems and system components, coordinated with the roofing system manufacturer.

B. Qualification Data: For Installer.

C. Product Certificates: For each type of roof adhesive for attaching the roof-mounted air terminal assemblies, approved by the roofing-material manufacturer.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For lightning protection system to include in maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Dimensioned site plan showing dimensioned route of the ground loop conductor and the ground rod locations. Comply with requirements of Section 017839 "Project Record Documents."
b. A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFPA 780, Annex D.

B. Completion Certificate:

1. Master Label Certificate

1.6 QUALITY ASSURANCE

A. Installer Qualifications: UL-listed installer, category OWAY or LPI Master Installer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.2 PERFORMANCE REQUIREMENTS

A. NFPA Lightning Protection Standard: Comply with NFPA 780 requirements for Class I Class II buildings.

B. UL Lightning Protection Standard: Comply with UL 96A requirements for Class I Class II buildings.

C. Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with UL 96, and marked for intended location and application.

2.3 MATERIALS

A. Air Terminals:

1. Copper, Stainless steel or Aluminum unless otherwise indicated.
2. 3/8-inch, 1/2-inch, 5/8-inch diameter by 10 inches, 12 inches, 15 inches, 18 inches, 24 inches long.
3. Rounded tip.
4. Integral base support, or Threaded base support.

B. Air Terminal Bracing:

1. Aluminum, Copper, Stainless steel, Galvanized steel.
2. 1/4-inch

C. Class 1 Main Conductors:

1. Stranded Copper: 57,400 circular mils in diameter.
2. Aluminum: 98,600 circular mils in diameter.

D. Class II Main Conductors:

1. Stranded Copper: 115,000 circular mils in diameter.
2. Aluminum: 192,000 circular mils in diameter.

E. Secondary Conductors:

1. Stranded Copper: 26,240 circular mils in diameter.
2. Aluminum: 41,400 circular mils in diameter.

F. Ground Loop Conductor: Stranded copper, Tinned copper.

G. Ground Rods:

1. Material: Solid copper - Copper-clad steel Stainless steel.
2. Diameter: 5/8 inch or 3/4 inch
3. Rods shall be not less than 120 inches long.
4. [Sectional type, with integral threads].

H. Conductor Splices and Connectors: Compression fittings that are installed with hydraulically operated tools, or exothermic welds, approved for use with the class type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A & NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid bends less than 90 degrees and 8 inches in radius and narrow loops.

C. Conceal conductors within normal view from exterior locations at grade within 200 feet of building. Comply with requirements for concealed installations in UL 96A, concealed systems in NFPA 780.

1. Roof penetrations required for down conductors and connections to structural-steel framework shall be made using listed through-roof fitting and connector assemblies with solid rods and appropriate roof flashings. Use materials approved by the roofing manufacturer for the purpose. Conform to the methods and materials required at roofing penetrations of the lightning protection components to ensure compatibility with the roofing specifications and warranty.
2. Install conduit where necessary to comply with conductor concealment requirements.
3. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.

D. Ground Ring Electrode: The conductor shall be not less than the main-size lightning conductor.

3.2 CONNECTIONS

A. Aboveground concealed connections, and connections in earth or concrete, shall be done by exothermic welds or by high-compression fittings listed for the purpose.

B. Aboveground exposed connections shall be done using the following types of connectors, listed and labeled for the purpose: bolted connectors, exothermic weld, high compression, crimp.

C. 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.

3.3 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Perform inspections as required to obtain a UL Master Label for system.
2. Perform inspections to obtain an LPI certification.

B. Prepare test and inspection reports and certificates.

END OF SECTION 264113

SECTION 265100 - INTERIOR LUMINAIRES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes interior luminaires, lamps, ballasts, and accessories.

B. Related Section:
1. Section 233713 - Air Inlets and Outlets: For interface with air handling fixtures.

1.2 LED LIGHTING FIXTURES AND COMPONENTS

A. Product Testing: Comply with U.L. 1598 and 8750. Test according to IES LM-79 and LM-80.

B. B. Drivers: Operation to be at standard rated voltage of driver, and not “over-driven.”

1.3 SUBMITTALS

A. Division 1 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate dimensions and components for each luminaire not standard product of manufacturer.

C. Product Data: Submit dimensions, ratings, and performance data.

D. Samples: Submit two color chips T3 x 3 inchTT (75 x 75 mm)T in size illustrating luminaire finish color where indicated in luminaire schedule.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.5 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.6 MAINTENANCE MATERIALS

A. Division 1 - Execution Requirements: Spare parts and maintenance products.

B. Furnish two of each plastic lens type.

PART 2 PRODUCTS

2.1 INTERIOR LUMINAIRES

A. Product Description: Complete interior luminaire assemblies, with features, options, and accessories as scheduled.

B. Refer to Division 1 - Product Requirements for product options.

2.2 LED LAMPS

A. Manufacturers:
   1. Phillips.
   2. General Electric Co.
   3. Osram.
   4. Substitutions: Division 1 - Product Requirements.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install suspended luminaires using pendants supported from swivel hangers. Install pendant length required to suspend luminaire at indicated height.

B. Support luminaires larger than T2 x 4 foot size independent of ceiling framing.

C. Locate recessed ceiling luminaires as indicated on Drawings.

D. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.

E. Install recessed luminaires to permit removal from below.

F. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

G. Install clips to secure recessed grid-supported luminaires in place.

H. Install accessories furnished with each luminaire.

I. Connect luminaires to branch circuit outlets provided under Section 260533 using flexible conduit.

J. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

K. Install specified lamps in each luminaire.

L. Ground and bond interior luminaires in accordance with Section 260526.

3.2 FIELD QUALITY CONTROL

A. Division 1 - Quality Requirements: Testing and inspection services, Starting and Adjusting: Testing, adjusting, and balancing.

B. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.3 ADJUSTING

A. Division 1 - Execution Requirements: Testing, adjusting, and balancing.

B. Aim and adjust luminaires as indicated on Drawings.

3.4 CLEANING

A. Division 1 - Execution Requirements: Final cleaning.

B. Remove dirt and debris from enclosures.

C. Clean photometric control surfaces as recommended by manufacturer.

D. Clean finishes and touch up damage.

3.5 PROTECTION OF FINISHED WORK

A. Division 1 - Execution Requirements: Protecting finished work.

B. Repair / replace luminaires having failed at Substantial Completion.

3.6 SCHEDULES

A. As indicated on Drawings.

END OF SECTION 265100

SECTION 283111 - FIRE ALARM SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section includes fire alarm control panels, manual fire alarm stations, automatic smoke and heat detectors, fire alarm signaling appliances, and auxiliary fire alarm equipment and power and signal wire and cable.

B. Related Sections:
1. Section 16123 - Building Wire and Cable.

1.2 REFERENCES

A. National Fire Protection Association:
1. NFPA 72 - National Fire Alarm Code.
2. BOCA Building Code.
3. National Electric Code.

1.3 SYSTEM DESCRIPTION

A. Fire Alarm System: NFPA 72, manual and automatic local fire alarm system with connections to an approved monitoring station.

B. Provide a complete Fire Alarm System as described herein and as shown on the plans; to be wired, connected, and left in an operating condition. The system shall use analog addressable initiating device circuits with individual device supervision, individual notification appliance circuit supervision, incoming and standby power supervision. Include control panels, power supplies, remote annunciators, manual pull stations, addressable interfaces to sprinkler system devices furnished by others (if applicable), and kitchen suppression systems furnished by others (if applicable), horns, strobes, remote control devices, wiring, connections to devices, outlet boxes, junction boxes, and all other necessary material for a complete operating system.

C. The fire alarm control panel shall allow for loading or editing special instructions and operating sequences as required. The system is to be capable of on-site programming to accommodate expansion, building parameter changes or changes as required by local codes. All software operations are to be stored in a non-volatile programmable memory within the fire alarm control panel. Loss of primary and secondary power shall not erase the instructions stored in memory.

D. All panels and peripheral devices shall be the standard product of a single manufacturer and shall display the manufacturer's name on each component. The catalog numbers specified under this section are those of Simplex constitute the material and desired operating features to be furnished.

1.4 OPERATION

A. Under normal condition, the front panel shall display a "SYSTEM NORMAL" message and the current time and date.

B. Should an abnormal condition be detected, the appropriate LED (“Fire Alarm”, “System

Supervisory", or "System Trouble") shall flash. The panel audible signal shall pulse for alarm conditions and sound steadily for trouble and supervisory conditions.

C. The panel shall have an eighty (80) character LCD display. The following information relative to the abnormal condition of a point in the system shall be displayed:

1. Custom location label describing the exact location of the device to include floor, room number (or nearest room number for corridor mounted devices). No two devices shall have the same location label. Provide forty (40) characters minimum to describe location information, this is in addition to the "type of device" and "status" requirements listed below.

A. The custom location label of each device shall be capable of being edited by the owner from the front panel controls. An off board programmer and or/computer shall not be required for the owner to change this information.

2. Types of device (i.e. smoke, pull station, waterflow). Provide twenty (20) characters minimum to describe device type information.

3. Point status (i.e. alarm, trouble, sprinkler supervisory). Provide twenty (20) characters minimum to describe point status.

D. Pressing the appropriate acknowledge button shall acknowledge the alarm or trouble condition. (The acknowledge, reset and bypass functions shall be pass-code protected. Three levels of pass-code protection shall be provided). If the user has insufficient privilege to acknowledge such conditions, a message shall indicate insufficient privilege but allow the user to view the points without acknowledging them. Should the user have sufficient privilege to acknowledge, a message will be displayed informing the user that the condition has been acknowledged.

E. Alarm Silencing

1. Should the "Alarm Silence" button be pressed, all audible notification appliances shall be deactivated. Visual indicating appliances shall continue to flash until the system is reset.

A. A dedicated "Alarm Silenced" LED indicator located on the front panel display shall be illuminated.

B. Should another alarm be reported, the audible notification appliances shall re-sound and the "Alarm Silenced" LED shall be extinguished until deactivated by the "Alarm Silence" button as described above.

F. System Reset

1. The "System Reset" button shall be used to return the system to its normal state after an alarm condition has been remedied. The display shall step the user through the reset process with simple English language messages. Messages shall provide operator assurance of the sequential steps (i.e.: "IN PROGRESS", "RESET COMPLETED", and "SYSTEM NORMAL") as they occur, should all alarm conditions be cleared.

2. Should an alarm condition continue to exist, the system will remain in an

abnormal state. System control relays shall not reset. The panel audible signal and the Alarm LED shall be on. The display will indicate the total number of alarms and troubles present in the system along with a prompting to review the points. These points will not require acknowledgment if they were previously acknowledged.

G. History Logging

1. In order to recreate a sequence of events in a fire or trouble investigation, the control panel shall store system abnormal conditions in three separate logs. Alarm activities shall be stored in an “Alarm Log”, sprinkler supervisory (tamper switch) activation in a “Supervisory Log”, and trouble events in a “Trouble Log”. The time and date of each occurrence must be included with each entry. These events shall be stored in a battery protected random access memory (RAM). In order to prevent re-occurring trouble and/or sprinkler supervisory conditions from overwriting other information, it is mandatory that each type of event be stored separately. Systems that are not equipped with separate logs, as described, shall include a UL listed fire alarm printer with battery back-up to record system activity including time and date of each occurrence.

H. Walk Test with History Logging

1. The system shall be capable of being tested by one person. While in testing mode, the alarm activation of an initiating device shall cause the system audible indicating devices to sound to in a coded pattern that uniquely identifies the initiating device that is activated. The panel shall then automatically reset itself after logging of the alarm.

2. The momentary disconnection of an initiating device, notification appliance, or the grounded condition of any circuit shall cause the system audible indicating appliances to sound for four (4) seconds. The panel shall automatically reset itself after logging of the trouble condition.

3. Should the walk test feature of the system be activated for eight (8) hours without testing activity, the system shall revert to the normal mode of operation automatically.

I. System Trouble Reminder

1. Should a trouble condition be present within the system and the audible trouble signal silenced, the trouble signal shall resound at eight (8) hour time intervals to act as a reminder to the owner that the fire alarm system is not 100% operational.

J. Smoke Sensor Operation

1. The smoke sensors shall automatically meet NFPA sensitivity testing requirements.

A. The control panel shall be listed as a calibrated sensitivity testing instrument that will automatically meet NFPA 72E Sensitivity Testing Requirements. The requirement to test the sensitivity of each detector within one year of installation and every alternate year thereafter as described in NFPA 72E shall not need to be performed manually.

2. The smoke sensors shall be smoke density measuring devices having no self contained alarm set-point. The alarm decision for each sensor shall be determined by the control panel. The control panel shall determine the condition of each sensor by comparing the sensor value to stored values.

3. The control panel shall maintain a moving average of the sensors smoke chamber value. The system shall automatically maintain a constant smoke obscuration sensitivity for each sensor and compensate for environmental factors such as dust accumulation.

4. The system shall automatically indicate when an individual sensor needs cleaning. When a sensor's average value reaches a predetermined value, a "Dirty Sensor" trouble condition shall be audibly and visually indicated at the control panel for the individual sensor. Additionally, the LED on the sensor base shall glow steady giving a visual indication at the sensor location.

   A. The smoke sensor shall not be operating at an increased sensitivity level due to the dust/dirt contamination. It shall continue to operate at the pre-set sensitivity level.

   B. Maintenance personnel shall be able to get a report of sensors that are “Almost Dirty” from the control panel display so that these sensors can be serviced while maintenance on the dirty sensors is being performed.

5. The control panel shall have the capability of being programmed for a pre-alarm or two-stage function. This function shall allow a "pre-alarm" indication to occur when, for example, a 3% sensor reaches a threshold of 1.5% smoke obscuration.

6. The control panel shall log the peak smoke obscuration level (for smoke sensors) or temperature (for heat sensors) at each device location. This shall enable an operator to set the sensitivity of individual sensors slightly above the normal environmental conditions in order to optimize the performance and reduce nuisance alarms within the system.

7. The device addressing mechanism shall permit the user to replace faulty sensors with spare units without the need for an electronic programming machine.

K. Notification Appliance Operation

1. The system shall provide for the synchronization and control of the audible and visible notification appliances on a common 2-wire circuit. Visual and audible signals shall be synchronized across all notification appliance circuits in the system. The audible notification signal shall be in a temporal code pattern as described by NFPA 72 and shall remain active until the “Alarm Silence” switch is activated at the fire alarm control panel (or at the remote annunciator panel). The visible notification appliances (xenon strobes) shall be synchronized and shall remain active until the system is reset.

1.5 ALARM SEQUENCE

A. The system alarm operation subsequent to the alarm activation of any manual station or automatic detection device is to be as follows:

1. All audible alarm notification appliances shall sound a temporal code pattern (.5 sec. on, .5 sec. off, .5 sec. on, .5 sec. off, .5 sec. on, 2.5 sec. off, then repeat) until silenced by the alarm silence switch at the control panel or at the remote annunciator panel.

2. All visible alarm notification appliances, Xenon Strobes, shall display a continuous pattern until the system is reset.

3. All doors normally held open by door control devices shall release.

4. The alarm signal shall be reported an off site monitoring facility. The digital communicator furnished with this project shall be programmed to report to the owners selected monitoring company.

5. The alarm is to be recorded with the time and date in the system's alarm log.

B. The alarm activation of any elevator lobby smoke detector shall, in addition to the operations listed above, cause the elevator cabs to be recalled according to the following sequence:

1. If the alarmed detector is on any floor other than the main level of egress, the elevator cabs shall be recalled to the main level of egress.

2. If the alarmed detector is on the main egress level, the elevator cabs shall be recalled to the predetermined alternate recall level as determined by the local authority having jurisdiction.

1.6 SUPERVISION

A. The disarrangement condition of any circuit shall not disrupt the operation of any other circuit.

B. Each addressable initiating device and independently supervised circuit shall include a discrete panel readout to indicate disarrangement conditions.

C. The incoming power to the system shall be supervised so that any power failure must be audibly and visibly indicated at the control panel. A green "power on" LED shall be displayed continuously while incoming power is present.

D. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visibly indicated at the control panel and remote annunciator.

E. The system shall provide for an operator to disable and enable each addressable device, indicating appliance circuit and each relay control circuit individually for maintenance or testing purposes.

F. If any addressable device is removed a "Device Missing" message along with the exact location of the missing device must be indicated at the fire alarm control panel and at the remote annunciator panel along with a system trouble indication.

G. If more than one addressable initiating device is inadvertently programmed with the same address, a “Duplicate Address” error shall be displayed on the control panel operators display.

1.7 POWER REQUIREMENTS

A. The control panel shall receive 120 VAC power (as noted on the plans) via a dedicated circuit.

B. The control panel shall contain four Notification Appliance Circuits for alarm horns and strobes as a minimum. Notification Appliance Circuit Extender Panels shall be furnished and installed as required to operate all notification appliances shown on the plans, or as required to meet the device power requirements, with 35% spare capacity per circuit for future additions.

C. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of sixty (60) hours with five (5) minutes of alarm operation at the end of this period. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operations shall be automatic. Batteries shall be sized to meet the requirements stated above with a 50% spare capacity for future additions.

D. All circuits requiring system operating power shall be 24VDC and shall be individually fused at the control panel.

1.8 SUBMITTALS

A. Division 1 - Submittal Procedures: Submittal procedures. Include bound data books.

B. Shop Drawings: Indicate system wiring diagram showing each device and wiring connection; indicate annunciator layout, and design calculations (i.e., voltage drop not to exceed 5%). A detailed battery calculation document indicating each control panel component and peripheral device along with the following information:

1. The quantity of each component

2. The stand-by and alarm power requirements of each component

3. Calculations to clearly indicate battery size needed to comply with the specification requirements.

C. Product Data: Submit catalog data showing electrical characteristics and connection requirements.

D. Where more than one product model is described on the manufacturers data sheet, the specific unit proposed shall be highlighted or otherwise identified.

E. Test Reports: Indicate procedures and results for specified field testing and inspection.

F. Manufacturer's Field Reports: Indicate activities on site, adverse findings, and recommendations.

1.9 CLOSEOUT SUBMITTALS

A. Division 1 - Execution Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of fire alarm equipment.

C. Operation and Maintenance Data: Submit manufacturer's standard operating and maintenance instructions.

1.10 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 50 miles of project.

B. Installer: Certified fire alarm installer with service facilities within 50 miles of Project.

C. Design fire alarm under direct supervision of NICET certified designer experienced in design of this Work.

1.11 MAINTENANCE SERVICE

A. Division 1 - Execution Requirements: Maintenance service.

B. Furnish service and maintenance of fire alarm equipment for one year from Date of Substantial Completion.

1.12 MAINTENANCE MATERIALS

A. Division 1 - Execution Requirements: Spare parts and maintenance products.

1.13 WARRANTY

A. Furnish one year manufacturer warranty for air handling units.

1.14 EXTRA MATERIALS

A. Division 1 - Execution Requirements: Spare parts and maintenance products.

B. Furnish two of each type of automatic smoke detector with base.

PART 2 PRODUCTS

2.1 CONTROL PANEL

A. Manufacturers:
1. Simplex Model 4100 Fire Alarm Control Panel, Remote Power Supplies and network card compatible with existing Simplex fire alarm network.
2. Pyrotronics MXL-IQ
3. Substitutions: Not Permitted.

B. The Control Panel shall have an 80-character LCD display and perform all functions listed in this specification. The display shall be backlit for enhanced readability. So as to conserve battery standby power, it shall not be lit during an AC power failure unless an alarm condition occurs or there should be keypad activity.

C. The Control Panel shall contain all necessary hardware and software required to monitor a minimum of 250 addressable devices and monitor and control four (4) notification appliance circuits. It shall contain a minimum of two (2) programmable auxiliary relays

and contain the circuitry to operate a serial controlled remote annunciator panel.

D. The control panel shall be capable of operating on a "peer-to -peer network" with similar control panels to enable individual system expansion and the capability to monitor, control and program systems in different facilities from one central location.

E. Provide network adapter card for connection to existing Simplex fire alarm network.

F. Provide cabinets of sufficient size to accommodate the aforementioned equipment. The cabinets shall be equipped with locks and transparent door panels providing freedom from tampering yet allowing full view of the various lights and controls.

2.2 NAC POWER EXTENDER PANELS

A. Furnish and install Notification Appliance Circuit Extender Panels as required to operate the alarm notification appliances shown on the plans. Allow for 50% spare capacity per circuit. Each power extender panel shall provide four (4) supervised notification appliance circuits and an 8 Amp power supply. The panel shall digitally communicate with the fire alarm control panel to provide for the synchronization and control of the audible and visible notification appliances on common 2-wire circuits. All visual and audible signals shall be synchronized across all notification appliance circuits in the system. The audible notification signals (horns) shall sound in a temporal code pattern as described by NFPA 72 and shall remain active until the “Alarm Silence” switch is activated at the fire alarm control panel (or at the remote annunciator panel). The visible notification appliances (xenon strobes) shall remain active until the system is reset. The four circuits shall be individually software controlled from the fire alarm control panel. The panel shall monitor each of its' output circuits for trouble conditions and report back to the fire alarm control panel, by circuit, if a trouble occurs. Each panel shall be equipped with stand-by batteries sized to provide sixty (60) hours of standby followed by five (5) minutes of alarm operation.

2.2 MANUAL FIRE ALARM STATIONS

A. Manufacturers:
1. By fire alarm panel manufacturer.
2. Substitutions: Not Permitted.

B. Product Description: Manual single-action addressable station.

C. Mounting: Semi-Flush (surface where required because of construction).

D. Type: Addressable..

E. Backbox: Manufacturer's standard.

2.3 CONVENTIONAL ZONE INTERFACE

A. Manufacturers:
1. ZAM Addressable by fire alarm panel manufacturer.
2. Substitutions: Not Permitted.

B. Product Description: MAPNET II Addressable conventional zone interface module to provide addressability to conventional circuits and to supervise and operate 24 VDC notification appliances.

2.4 CONVENTIONAL ZONE INTERFACE

A. Manufacturers:
1. IAM Addressable by fire alarm panel manufacturer.
2. Substitutions: Not Permitted.

B. The units shall provide location specific addressability to non-addressable devices such as waterflow, sprinkler tamper switches, and kitchen suppression systems, furnished by others, by monitoring normally open dry contacts. Closure of the monitored contact shall initiate an alarm or supervisory condition, as required. An open in the initiating circuit will cause a trouble to be reported at the fire alarm control panel. Units shall mount in a standard single gang electrical box.

2.5 SPOT HEAT DETECTOR

A. Manufacturers:
1. Addressable by fire alarm panel manufacturer.
2. Substitutions: Not Permitted

B. Product Description: NFPA 72 ceiling heat detector with the following features:
1. Combination rate-of-rise and rate compensated fixed temperature sensor of which both operations are self-restoring.
2. The sensor's small thermal mass shall allow an accurate up-to-date temperature reading of each sensor to be logged at the control panel. The rate of rise operation shall be selectable in either a 15-degree per minute or a 20-degree per minute rate of temperature rise. The fixed temperature principle shall operate entirely independent of the rate of rise principle and shall be selectable for either 135 degrees or 155 degrees Fahrenheit.
3. The heat detectors shall be UL listed to standard 521 for sixty (60) foot spacing at the 135 degree setting and forty (40) foot spacing at the 155 degree setting.

Note: Heat sensors located in Data Closets shall be programmed as utility devices to monitor for temperature extremes in these areas. If any of these sensors detect temperatures exceeding 95 degrees Fahrenheit, a separate signal shall be transmitted to the Campus Police Office to alert of possible HVAC system problems that could affect data system operation. The fire alarm sequence shall not be initiated

C. Temperature Rating: 135 degrees F.

D. Rate-of-Rise: 15 degrees F.

2.6 CEILING SMOKE DETECTOR

A. Manufacturers:
1. Addressable by fire alarm panel manufacturer.
2. Substitutions: Not Permitted.

B. Product Description: NFPA 72 photoelectric type ceiling smoke detector with the following features:
1. Sensors shall be of the photoelectric type and shall communicate actual smoke chamber values to the system control panel.
2. The sensors shall be listed to UL Standard 268 and shall be documented compatible with the control equipment to which they are connected.
3. The sensors shall be listed for both ceiling and wall mount applications.

4. The sensitivity of each individual detector shall programmable from the control panel.
5. The sensors shall automatically compensate for the accumulation of dust and dirt to maintain operation at their programmed sensitivity level as these contaminates accumulate. The control panel shall identify the need for individual sensors to be cleaned before the contamination effects their sensitivity. In order to assist maintenance personnel, the control panel shall report sensors that are “almost dirty” so that these units can be serviced at the same time as sensors reporting a “dirty” condition. The sensors shall be documented to automatically meet NFPA sensitivity testing requirements.
6. Smoke sensors shall mount to a Simplex #4098-9794 sounder base for all rooms.

C. Mounting: Manufacturer’s standard outlet box.

2.7 DUCT-MOUNTED SMOKE DETECTOR

A. Manufacturers:
1. Addressable by fire alarm panel manufacturer.
2. Substitutions: Not Permitted.

B. Product Description: NFPA 72 photoelectric type with the following features:
1. The sensors shall meet the requirements of UL Standard 268A and shall be documented compatible with the control equipment to which they are connected.
2. The addressable duct smoke sensors shall operate on the light-scattering, photodiode principal, and shall communicate actual smoke chamber values to the system control. The sensors shall not have a self contained smoke sensitivity setting and shall automatically compensate for environmental changes. The sensor's electronics shall be completely shielded to protect against false alarms from EMI and RFI.
3. The duct housing shall contain a transparent cover with a visible red and yellow LED which shall indicate normal, alarm, and trouble conditions including supervision of the remote relays.
4. The Duct housing supervised output to drive a remotely mounted 4098-9843 SPDT auxiliary relay rated at 10 amps @ 120VAC or 7 amps @ 28VDC for unit shutdown. This relay output must be programmable from the fire alarm control panel to operate independently of detector activation to provide total unit shutdown and bypass control from the fire alarm control panel. Up to 15 of these relays can operate on this supervised duct detector output. Relays will mount in a 4 inch square box with cover.
5. The duct detectors shall obtain 24VDC operating power from the fire alarm control panel.
6. The duct detectors shall utilize cross sectional sampling principle by which a sampling tube is extended across the duct to continuously sample the air movement through the duct, after which the sampled air is returned to the duct via an exhaust tube. Sampling tubes shall be properly sized for the duct in which they are installed. The duct housing shall include a magnetic test area and test ports to allow magnetic and aerosol testing without removal of the housing cover.
7. Provide a Simplex type 2098-9806 Remote Alarm Indicator, located next to FACP, with Test Keyswitch for each duct smoke sensor installed.
8. Duct sampling tubes shall extend width of duct.

2.8 STROBES

A. Manufacturers:
1. Simplex type 4904-9331 Synchronized Visible Units.
2. Substitutions: Not Permitted.

B. Product Description: NFPA 72 Audible Only and Audible/Visible with the following features:
1. The appliances shall provide minimum 75 cd illumination and have a flash rate of 1 Hz over the entire operating voltage range as required by the Americans with Disabilities Act (ADA). Provide 110 cd where shown.
2. The notification appliances shall be UL listed to Standard 1971.
3. The specified control panel shall provide for the synchronization and control of the system audible and visible notification appliances on a common 2-wire circuit.
4. The visible notification signals (xenon strobes) shall be synchronized and shall remain active until the system is reset. The units shall be labeled with the word "FIRE" in a contrasting color and the height of each character shall be a minimum of 5/8". In its' quiescent state, the word "FIRE" shall be visible. The devices shall semi-flush mount directly to standard single gang, double gang, and 4” square electrical boxes without the use of special adapters or trim rings.

2.9 ALARM HORN and HORN/STROBE

A. Manufacturers:
1. Simplex type SmartSync.
2. Substitutions: Not Permitted.

B. Product Description: NFPA 72 strobe lamp and flasher with red lettered "FIRE" on white housing.

C. Product Description: NFPA 72 Audible Only and Audible/Visible with the following features:
1. Polycarbonate lens.
2. The visible portion of the appliances shall provide a minimum 75 cd illumination and have a flash rate of 1 Hz over the entire operating voltage range as required by the Americans with Disabilities Act (ADA). Provide 110 cd where shown.
3. The output of the audible portion of the appliance shall be rated at 91dBA at 10 feet. The notification appliances shall be UL listed to Standards 1971 and 464. The specified control panel shall provide for the synchronization and control of the audible and visible portions of these devices on a common 2-wire circuit.
4. The audible notification signal shall be in a temporal code pattern as described by NFPA 72 and shall remain active until the “Alarm Silence” switch is activated at the fire alarm control panel (or at the remote annunciator panel).
5. All visible notification signals (xenon strobes) shall be synchronized and shall remain active until the system is reset.
6. The units shall be labeled with the word "FIRE" in a contrasting color and the height of each character shall be a minimum of 5/8". In its' quiescent state, the word "FIRE" shall be visible.
7. The devices shall semi-flush mount directly to standard single gang, double gang, and 4” square electrical boxes without the use of special adapters or trim rings.

2.10 WATERFLOW AND OS&Y MONITOR SWITCHES

A. Waterflow and OS&Y Monitor Switches shall be furnished and installed under other sections of these specifications but shall be wired and connected to the Fire Alarm System by the Electrical Contractor.

2.11 DOOR RELEASE

A. Manufacturers:
1. By fire alarm panel manufacturer.
2. Substitutions: Not Permitted.

B. Product Description: Magnetic door holder with integral diodes to reduce buzzing.

C. Coil voltage: 24 VDC.

2.12 WIRE AND CABLE

A. Manufacturers:
1. Fire alarm manufacturer's required cable, Cu conductors. Addressable circuits shall use minimum twisted, shielded pair #18AWG Cu wire and shall allow for T-tapping of the circuit (all wiring on addressable circuits shall be approved by the system manufacturer). Use minimum #14AWG Cu conductors for indicating circuits, and #12AWG-Cu for power circuits.
2. Substitutions: Not Permitted.

B. Product Description: Non-power limited fire-protective signaling cable, copper conductor, THHN insulation rated 90 degrees C. Power limited fire-protective signaling cable, copper conductor, 300 volts insulation rated 105 degrees C.

C. Wiring Within Enclosures: Install conductors parallel with or at right angles to the sides and back of the enclosure. Bundle, lace, and train the conductors to terminal points with no excess. Mark each terminal according to the wiring diagrams of the system. Make all connections with the manufacturer's approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Plenum Cable: Power limited fire-protective signaling cable classified for fire and smoke characteristics, copper conductor, 300 volts insulation rated 105 degrees C, suitable for use in air handling ducts, hollow spaces used as ducts, and plenums.

E. Wiring to Central Station Transmitter: 1-inch (Size 27) conduit between the FACP and the central station transmitter connection as indicated. Install number of conductors and electrical supervision for connecting wiring as required to suit central-station monitoring function.

F. Fire alarm circuit conductors have insulation color or code as follows:
1. Power Branch Circuit Conductors: Black, red, white.
2. Initiating Device Circuit: Black, red.
3. Detector Power Supply: Violet, brown.
4. Signal Device Circuit: Blue (positive), white negative.
5. Door Release: Gray.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 1 - Administrative Requirements: Coordination and project conditions.

B. Verify products and systems receiving devices are ready for installation.

3.2 INSTALLATION

A. Install 14 AWG minimum size conductors for fire alarm detection and signal circuit conductors in red MC conduit.

B. Install signal wire in red MC conduit.

C. Connect system to elevator recall and, if required, elevator power shutdown.

D. Mount end-of-line device in control panel or box with last device or separate box adjacent to last device in circuit.

E. Mount outlet box for electric door holder to withstand 80 pounds pulling force.

F. Connect conduit and wire to door release devices, sprinkler flow switches, sprinkler valve tamper switches, fire suppression system control panels and duct smoke detectors. Provide all required addressable modules.

G. Automatic Detector Installation: Conform to NFPA 72.

H. Install engraved plastic nameplates in accordance with Division 16.

I. Ground and bond fire alarm equipment and circuits in accordance with Division 16.

J. Manual Pull Stations: Mount semi-flush in recessed back boxes with operating handles 44 inches above finished floor or as indicated.

K. Smoke Detectors: Install ceiling-mounted detectors in center of corridors or as indicated on the drawings but not less than 4 inches (100 mm) from a side wall to the near edge. Install detectors located on the wall at least 4 inches (100 mm) but not more than 12 inches (300 mm) below the ceiling. For exposed solid joist construction, mount detectors on the bottoms of the joists. On smooth ceilings, install detectors not over 30 feet (9 m) apart in any direction. Install detectors no closer than 5 feet (1500 mm) from air registers.

L. Audible Alarm-Indicating Devices: Install not less than 80 inches above the finished floor nor less than 6 inches (160 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille or as indicated. Combine audible and visual alarms at the same location into a single unit.

M. Visual Alarm-Indicating Devices: Install at 80 inches (2000 mm) above the finished floor or 6 inches (150 mm) below the ceiling, whichever is lower.

N. Remote Alarm Indicators/Test Switches: Locate in the public space immediately adjacent to the device they monitor.

O. Fire Alarm Control Panel (FACP): Surface mount with tops of cabinets not more than 6 feet (1800 mm) above the finished floor.

P. Remote Annunciator: Arrange as indicated, with the top of the panel no more than 6 feet (1800 mm) above the finished floor.

3.3 FIELD QUALITY CONTROL

A. Division 1 - Quality Requirements: Testing and inspection services 01700 - Execution Requirements: Testing, adjusting, and balancing.

B. Test in accordance with NFPA 72 and local fire department requirements Provide certificate that system was tested.

3.4 MANUFACTURER'S FIELD SERVICES

A. Division 1 - Quality Requirements: Manufacturer’s field services.

B. Include services of factory trained technician to supervise installation, adjustments, final connections, and system testing.

3.5 DEMONSTRATION AND TRAINING

A. Furnish 16 hours of instruction each for maintenance personnel to be conducted at project site with manufacturer's representative.

3.6 WARRANTY

A. Provide one years manufacturer’s warrentee on all parts and workmanship.

END OF SECTION 283111

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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Material Ownership.
2. Project Conditions.
3. Materials.
4. Execution.

1.3 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain the Owner's property, cleared, removed or demolished materials shall become the Contractor's property and be removed in their entirety from the project site.

1.4 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the Owner and all authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by the Owner or all authorities having jurisdiction.

B. Salvable Improvements: Carefully remove items indicated to be salvaged and transport to Owner-directed location(s).

C. Utility Locator Service: Notify utility locator service for area where project is located before site clearing.

D. Do not commence site clearing and demolition operations until temporary erosion and sedimentation control and tree protection / site feature protection measures are in place.

E. The following practices are prohibited within tree / site feature protection zones:

1. Storage 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 unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points during construction.

B. Locate and identify trees, shrubs, and other vegetation to remain or to be relocated.

C. Identify and protect existing site improvements indicated to remain during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner, at the Contractor’s sole cost and expense.

D. Locate and identify limits of building demolition work done under previous contract. Notify Owner and/or Engineer of any unremoved items from building demolition work prior to Bid submittal. No adjustments to Contract Time or Contract Amount will be considered for removal of items remaining due to previous contract work.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion and sedimentation control interim and final Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion and sedimentation control measures during construction per the plan narrative(s) until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. 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 the Owner at the Contractor's sole expense.

3.4 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with appropriate Facility Owner to shut off indicated utilities.

B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner and Facility Owner not less than three (3) days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Owner's and Facility Owner's written permission.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Grind stumps and remove roots, obstructions, and debris to a depth of eighteen (18")-inches below exposed subgrade.
2. Use only hand methods for grubbing within protection zones.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of eight (8")-inches. Compact each lift to a density equal to or greater than adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to the depths encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.

C. Stockpile topsoil at Owner-directed locations or as indicated on the Drawings away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Stabilize topsoil stockpile(s) as indicated on the Drawings.

3.7 SITE IMPROVEMENT REMOVAL

A. Remove existing above- and below-grade site improvements as indicated and necessary to facilitate new construction observing all Federal, State, Owner and Facility Owner requirements. Fully comply with all notes on the Existing Conditions and Demolition Plan. All removed improvements shall be transported to and disposed of in a fully permitted off-site facility.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable and/or excess topsoil, obstructions, trees, shrubs, logs, chips, demolished site improvements and waste materials including trash and debris, and legally dispose of them off Owner's property at a fully permitted facility.

B. Separate recyclable materials produced during site clearing operations from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other project work.

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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Preparing subgrade for slabs on grade, walks, walls, pavements, lawns and grasses and landscaping.

1.3 DEFINITIONS

A. Backfill: Soil material or aggregate material used to fill a trench excavation.

1. Initial backfill (“Pipe Zone”): The area from the pipe invert to one (1’) foot above the crown of the pipe for the full width and length of the trench.

B. Base Course: Course placed between the subgrade course and sidewalks, concrete pavement and hot mix asphalt paving.

C. Bedding Course: Six (6”)-inches of AASHTO #57 Limestone placed over the excavated subgrade in a trench to the pipe invert.

D. Borrow: Satisfactory soil material, free of organic or other deleterious material imported from off the project site for use as fill or backfill.

E. Drainage Course: Course of washed granular material meeting AASHTO #57 limestone supporting the slab on grade that also minimizes upward capillary flow of pore water.

F. Bulk Excavation: Completion of all excavation (“cuts”) and structural fills to the lines and grades as shown on the Drawings.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by the Owner. Authorized additional excavation and replacement material will be paid for according to Contract provisions.
2. Satisfactory Material: Soil whose composition is satisfactory for use in embankment construction. In general, any mineral (inorganic) soil, blasted or broken rock, and similar materials of natural or man-made origin including mixtures thereof.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by the Owner. Unauthorized excavation, as well as remedial work directed by the Owner, shall be at the Contractor’s sole expense.
4. Unsatisfactory Material: Any soil containing vegetation or organic matter, such as muck, peat, organic silt, topsoil or sod, which is not satisfactory for use in embankment construction or for support of permanent structures. Certain manmade deposits such as land-fill material may also be determined to be unsatisfactory material.

G. Trench Excavation: Removal of all material encountered above subgrade elevations and to lines and dimensions indicated regardless of type encountered.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by the Owner. Authorized additional excavation and replacement material will be paid for according to applicable Contract provisions.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by the Owner. Unauthorized excavation, as well as remedial work directed by the Owner to correct unauthorized excavation, shall be at the Contractor’s sole cost and expense.

H. Fill: Soil materials used to raise existing grades.

I. Pipe Zone: The area from the pipe invert to one (1’) foot above the crown of the pipe for the full width and length of the trench

J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below base, drainage fill, or topsoil materials.

K. Topsoil: Natural or cultivated surface-soil layer containing not less than two (2%) percent nor more than ten (10%) percent of organic matter, as specified in AASHTO designation T194. The material contains sand, silt, and clay particles; 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 two (2”) inches in diameter. Topsoil shall be free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

M. Final backfill: Aggregate material or fill placed over initial backfill to fill a trench to final grades indicated on drawings.

N. PennDOT: Pennsylvania Department of Transportation.

O. AASHTO: American Association of State Highway and Transportation Officials.

P. ASTM: American Society for Testing and Materials.

Q. OSHA: Occupational Safety and Health Administration.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Each type of geotextile and geogrid.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities unless permitted in writing by the Facility Owner and the Owner and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Facility Owner and the Owner not less than three (3) days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without the Facility Owner's written permission.
3. Obtain PA One Call Number prior to beginning work.

B. Demolish and completely remove from site existing underground utilities indicated to be removed unless directed otherwise. Coordinate with Facility Owners to shut off services if lines are active.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow materials when sufficient satisfactory soil materials are not available from bulk excavations.

B. Base or Subbase Material: AASHTO #57 limestone or PennDOT 2A limestone as required.

C. Engineered Granular Fill: High-quality granular soil meeting AASHTO T27 for gradation: one hundred (100%) percent passing four (4") sieve; zero to seventy (0 to 70%) percent passing #40 sieve and zero to fifteen (0 to 15%) percent passing # 200 sieve. Additional general considerations include plasticity index (PI) (AASHTO T90): PI < six (6%) percent.

D. Drainage Course: AASHTO No. 57 limestone.

E. Filter Material: Narrowly graded mixture of crushed stone and natural sand; ASTM D 448; coarse-aggregate grading AASHT0 No. 67; with 100 percent passing a one (1")-inch sieve and zero (0%) to five (5%) percent passing a No. 4 sieve.

F. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

G. Sand: ASTM C 33, fine aggregate, natural, or manufactured sand.

H. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, GC, SW, SP, SM, SC, ML and CL or a combination of these groups; free of rock or gravel larger than three (3”)- inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

I. Unsatisfactory Soils: ASTM D 2487 Soil Classification Groups OL, CL, MH, OH and PT expansive or carbonaceous shales and soils that cannot maintain an optimum moisture content of three (3%) percent at the time of compaction.

2.2 GEOTEXTILES

1. Subsurface Drainage Geotextile: Shall comply with the requirements of a Class 1 geotextile in Section 735 of PennDOT Publication 408 (most current edition).
2. Separation Geotextile: Shall comply with the requirements of a Class 4 Type A geotextile in Section 735 of PennDOT Publication 408 (most current edition).

2.3 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of six (6”) inches wide and four (4) mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to thirty (30”) inches deep, colored to comply with local practice or requirements of authorities having jurisdiction.

2.4 GEOGRIDS FOR SEGMENTAL RETAINING WALLS

1. Geogrid: Shall comply with all requirements of the Design Manual for Segmental Walls (3rd Edition and most recent updates) as published by the National Concrete Masonry Association (NCMA).

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by bulk excavation operations. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades and from flooding project site and surrounding areas.

B. Preparation of subgrade for bulk excavation and trenching operations shall include removal of trees, vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface. See Division 31 Section “Site Clearing” for additional requirements.

3.2 DEWATERING

A. Prevent surface water and ground water from entering bulk excavations and trench excavations. Do not allow water to pond and collect on prepared subgrades. Do not allow water to flood project site and/or surrounding properties.

B. Protect subgrades and trenches from softening, undermining, washout, and damage by rain or water accumulation.

C. Provide and maintain all temporary drainage and dewatering systems, such as pumps, sumps, well points and discharge lines as required during bulk excavation and trench excavation at no additional cost to the Owner. The determination of the type and size of dewatering system necessary to meet these requirements shall be the sole responsibility of the Contractor.

D. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations and trenches. Do not use excavated trenches as temporary drainage ditches.

E. During grading operations, pits, cuts, excavation areas and/or embankments and subgrades shall be shaped, sloped and maintained to facilitate drainage of surface water. Existing drainage routes shall not be choked or obstructed until new ones are established. Temporary culverts, pumps or other equipment shall be used to facilitate drainage of fills during construction.

F. Care shall be exercised during excavations to avoid discharge of surface flows across watershed lines.

3.3 BULK EXCAVATION REQUIREMENTS

A. The Contractor shall be responsible for bulk excavation of all material encountered regardless of type. All bulk excavation material shall be considered as unclassified. The Contractor shall be responsible for all required excavation, including trench excavation, through all types of encountered material including, but not limited to, soil, rock, and building and pavement materials (whether evident on the surface or not). No changes in the Contract Sum or the Contract Time will be authorized for rock excavation.

B. The Contractor shall excavate all materials as required to the dimensions and grades indicated on the Drawings.

C. The Contractor shall complete bulk excavation and fill embankment procedures to subgrade surface elevations conforming to finish grade elevations.

D. The Contractor shall be responsible at all times for carrying out all excavation operations in a safe and prudent manner so that all persons and property will be protected from hazard.

E. The Contractor shall prepare and submit to the Engineer a Construction Schedule for bulk excavation and trenching operations prior to beginning work. No work may begin until an approved Construction Schedule is returned by the Engineer to the Contractor.

F. The Contractor shall be responsible for the offsite disposal of all surplus excavated or trenched material. Prior to commencement of work, the Contractor shall advise the Owner of the quantity of surplus material, if any, he estimates will be disposed of offsite. The Contractor shall provide the Owner with a copy of the approved grading permit, Property Owner liability releases and the approved Erosion and Sedimentation Control Plan for the offsite disposal site. All offsite facilities shall be fully permitted at no additional cost to the Owner.

G. In the event the Contractor disposes of too much excavated material, he shall replace the material as necessary and required at his sole cost and expense. Material to be replaced shall meet the requirements for satisfactory material as specified herein and shall be subject to the approval of the Owner.

H. The existing surface, subsurface and base may consist of any or all of the following materials: asphalt, plain concrete, brick pavers, cobblestone pavers, reinforced concrete, coarse aggregate, cinders, sand, slag, unclassified fill previously placed, rock, building debris and remnants and in-situ natural soils. Removal of the existing surface, subsurface and base shall include the removal of any materials encompassing manholes, utility boxes, utility lines, and trench lines.

I. All excavations and trenching shall be considered as unclassified. No additional compensation, other than time, will be considered for excavation through any encountered subsurface materials.

J. The Contractor shall provide all necessary measures to control dust through the use of water, calcium chloride, or other material approved by the Owner, at such locations and during such periods as directed or as be required by the Owner.

1. Calcium Chloride shall be spread in pellet or flake form by approved devices so that uniform distribution is attained over the entire area being treated.
2. Watering equipment shall consist of pipelines, tanks, tank trucks or other approved devices capable of applying a uniform spread of water over the surface. A suitable device for regulating the flow and positive shut-off of the water shall be provided for positive control by the operator.
3. The Owner will advise the Contractor of any unsatisfactory procedures used for dust control. If the unsatisfactory procedures are not corrected promptly, the Owner may suspend the performance of any or all construction until the condition has been corrected.
4. Payment for dust control shall be considered incidental to bulk excavation.

3.4 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus one (1") inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work. Follow all recommendations in the Geotechnical Report.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

3.5 TRENCH EXCAVATION

A. The Contractor shall protect installed pipe at all times during construction.

B. Trench excavation shall conform to the line and grade of the sewer or utilities as shown on the Drawings and according to minimum manufacturer's recommended trench widths.

C. All excavations shall be kept free from water, snow and ice during construction.

D. Mats shall be placed for excavation equipment where damage could be caused to existing pavements.

E. The minimum trench width shall be the outside diameter of the pipe plus twelve (12") inches on both sides of the pipe to ensure proper compaction of the bedding and backfill or as recommended by the pipe manufacturer. The maximum trench width shall conform to current ASTM and OSHA requirements predetermined by the depth of the excavation and pipe size or as required by site conditions. No additional compensation will be considered for required trench widths caused by existing site conditions or necessary to meet ASTM, OSHA or pipe manufacturer requirements. The allowable maximum pay width for trench excavation shall be outside diameter of the pipe plus eighteen (18") inches on both sides of the pipe regardless of depth. If the actual trench width exceeds the maximum pay width, no payment will be made for the additional excavation, sheeting, shoring, backfill, asphalt or other surface treatments outside the maximums. The cost of such excess shall be borne by the Contractor at his sole cost and expense.

F. The bottom of the trenches shall be prepared to conform to the grade of the pipe and the bottom of the foundation of structures. Special precautions shall be exercised to insure that pipes, when installed, will not rest on rock, masonry or any other material that would present a non-uniform foundation. Where two or more pipes are to be laid in the same trench, the Contractor shall excavate the trench so that all pipes are laid in conformance with the specified pipe detail.

G. Excavation below Required Grade: Excavation below the grade of pipes or subsurface structures shown on the Drawings necessitated by changes in grades in accordance with the directions of the Owner will be paid under "Trench Excavation / Authorized Additional Excavation", as hereinafter defined. Excavation carried below the required level without authorization by the Owner shall be backfilled at the Contractor's sole cost and expense with approved aggregate material. Compaction of such backfill material shall be as specified elsewhere herein.

H. Excavation in Paved Areas: When excavations are to be made in paved surfaces, the paved surfaces shall be neatly cut one (1') foot beyond each side of the trench and ahead of the excavation by means of pneumatic tool, saw cutting or other approved tools to provide a clean, uniform edge, with minimum disturbance of remaining pavements. The pavements so removed shall not be used for trench backfill, but shall be disposed of offsite in an approved manner.

I. Surplus Excavated Material: The Contractor shall remove all excess excavated material from the site or haul it to an on-site Owner-approved stockpile for offsite removal before project completion

3.6 EXCAVATION FOR CONCRETE WALKS AND PAVEMENTS

A. Excavate surfaces under concrete walks and pavements to indicated lines, cross sections, elevations, and subgrades to a tolerance of one-half (1/2") of an inch.

3.7 EXCAVATION FOR SEGMENTAL RETAINING WALLS

A. Excavate surfaces under and behind segmental retaining walls walks to indicated lines, cross sections, elevations, and subgrades to a tolerance of one-half (1/2") of an inch or as listed on the approved design plans.

3.8 DISPOSAL OF MATERIAL OUTSIDE OF THE WORK SITE

A. The Contractor shall dispose all waste and excess materials offsite and shall be responsible for all costs, including permitting, incurred thereof. The Contractor shall be solely responsible for locating suitable disposal sites prior to beginning work.

B. The Contractor shall first obtain written permission from the offsite property owner on whose property the disposal is to be made. He shall file with the Owner said permission or a certified copy thereof, together with a written release from the property owner, absolving the Owner from any and all responsibility in connection with the disposal of material on said offsite property.

C. During the disposal of waste and excess materials, the Contractor shall comply with all Federal, State and local governmental rules, regulations, laws and ordinances concerning such disposal of waste and excess materials. All offsite disposal sites shall be fully permitted prior to beginning work.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavations under pavement, sidewalks, landscaping areas, utilities, sewer lines and other construction areas with satisfactory soil to subgrade in accordance with the soil fill requirements at no additional cost to the Owner.

3.10 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than ten (10”) inches in loose depth for material compacted by heavy compaction equipment, and not more than four (4”) inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557, D 4253 and D 4254.

1. Cohesive materials shall be compacted to a minimum of ninety five (95%) percent of the maximum modified dry density in accordance with ASTM D 1557 at water contents within three (+/- 3%) percent of the optimum water established by that test.

2. For utility trenches, compact each layer of initial and final backfill material to at least seventy (70%) percent relative density in accordance with D 4253 and D 4254.

3.11 AGGREGATE PIPE BEDDING

A. Aggregate Bedding: Bedding in the “Pipe Zone” shall consist of a minimum of six (6)-inches of approved AASHTO #57 limestone installed below the pipe for the entire trench width. In addition, a minimum of twelve (12”)-inches of approved AASHTO #57 limestone shall be installed above the crown of the pipe as well as placed in the trench alongside the pipe from the invert to the crown. The bedding shall be placed in six (6”)-inch loose lifts and compacted using mechanical compaction equipment to seventy (70%)-percent relative density per ASTM D 4253 and ASTM D 4254.

3.12 TRENCH BACKFILL FOR PIPE AND PIPE STRUCTURES

A. Under non-paved areas and outside eight (8)-feet of structures and/or curbs, the backfill shall be approved select on-site material placed to within four (4”)-inches from the final proposed elevation to allow for topsoil placement and compaction. Select on-site material shall be placed in eight (8”)-inch loose lifts mechanically compacted to ninety five (95%) modified Proctor density per ASTM D 1557.

B. Under pavement and within eight (8’)-feet of structures and/or curbs:

1. Backfill shall be approved PennDOT 2A limestone placed in six (6”)-inch lifts to the subgrade elevation of the proposed impervious surface from twelve (12”)-inches above the crown of the pipe compacted using mechanical compaction equipment to seventy (70%)-percent relative density per ASTM D 4253 and ASTM D 4254.

C. Backfilled areas which settle shall be repaired at the Contractor's sole cost and expense.

3.13 TRENCH BEDDING AND BACKFILL FOR UTILITIES

A. The Contractor shall bed and backfill trenches for utilities in accordance with the requirements of the Facility Owner having jurisdiction for the utility being installed.

3.14 AGGREGATE FOR SEGMENTAL RETAINING WALLS

A. The Contractor shall install aggregate for leveling pads and drainage in accordance with the approved Plans and/or industry accepted standards.

3.15 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
3. Slope grades to direct water away from buildings and to prevent ponding.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus one (1”) inch.
2. Concrete Walks: Plus or minus one-half (1/2”) inch.
3. Pavements: Plus or minus one-half (1/2”) inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of one half (1/2”) inch when tested with a ten (10)-foot straightedge or as directed by the Owner, Engineer and/or Architect.

3.16 GEOTEXTILE INSTALLATION

A. The Contractor shall be required to install Class 4, Type A geotextile fabric on the subgrade prior to installing the stone subbase.

1. The Contractor shall install Class 4, Type A geotextile fabric in general accordance with the requirements set forth in Section 212 of PennDOT Publication 408 (most current edition). The maximum overlap between rolls shall be twelve (12”) inches with no additional compensation considered for the cost of overlapping or pins required for installation.
2. The geotextile shall be pinned to the subbase using eight (8) penny aluminum nails spaced twelve (12”) inches center to center or as recommended by the manufacturer.
3. Trucks shall not be permitted to travel over the fabric while aggregate is being installed. The aggregate shall be placed on the fabric by dumping the trucks and then blading the aggregate onto the fabric with a front loader. The aggregate shall be dropped onto the fabric and not shoved over it.
4. Protect the geotextile fabric from traffic and other damage. Install subbase material on the same day the fabric was placed.

3.17 GEOGRID INSTALLATION FOR SEGMENTAL RETAINING WALLS

A. The Contractor shall install geosynthetic reinforcement per the approved design Plans and Details in accordance with the manufacturer’s recommendations and accepted industry standards.

3.18 SUBBASE FOR CEMENT CONCRETE PAVEMENT AND WALKS

A. Concrete Sidewalk and Driveway subbase shall be in accordance with applicable Specification Sections and Details.

B. Shape subbase to required crown elevations and cross-slope grades.

C. Place subbase six (6”) inches or less to compacted thickness in a single layer.

D. Compact subbase course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than seventy percent (70%) density as per ASTM D4253 and D4254.

3.19 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 or temporarily seed to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

2. Stockpile topsoil for re-use in Owner-designated areas.

3.20 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and re-establish 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 the Owner. Reshape and re-compact.

C. Where settling occurs before project correction period elapses, remove finished surfacing, backfill with additional competent material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible at the Contractor’s sole cost and expense.

END OF SECTION 312000

SECTION 321216 – ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hot mix asphalt paving.
2. Cold milling of existing bituminous pavement.
3. Aggregate base.
4. Keyways.

1.3 DEFINITIONS

A. Hot Mix Bituminous Paving Terminology: Refer to ASTM D8 for definitions of terms.

B. Hot Mix Asphalt Paving: Bituminous paving or material.

C. PennDOT: Pennsylvania Department of Transportation.

1.4 SUBMITTALS

A. Job Mix Designs and Certifications – Supply the following as indicated:

1. PennDOT certification and job mix formulas from the supplier for the bituminous materials for the proposed work shall be submitted for approval a minimum of seven (7) days prior to the pre-construction conference.
2. PennDOT Form TR 465 (Daily Bituminous Mixture Certification) supplied daily for each day bituminous material is delivered to the project site.
3. PennDOT Form CS-4171 (Certificate of Compliance) and Form TR-448A (Job Mix Formula Report) supplied daily for each day bituminous material is delivered to the project site.
4. Material Supplier's Bill of Lading indicating the temperature of the material leaving the plant, the type of material, the net weight of the material in the truck and a cumulative total tonnage of material being installed shall be submitted on a daily basis.
5. Tack Coat: PennDOT certification and source of material shall be submitted a minimum of seven (7) days prior to the pre-construction conference. Material Supplier's Bill of Lading shall be submitted on a daily basis.

B. Qualification Data: PennDOT pre-qualification certifications for all proposed contractors and suppliers meeting the appropriate classifications for the project and a minimum of three (3) references for previously completed projects shall be submitted for approval a minimum of seven (7) days prior to the pre-construction conference. Suppliers shall be listed on

PennDOT Bulletin 41 (Bituminous) for all proposed job mixes unless approved in writing by the Owner and/or Engineer.

C. Material Test Reports: For all installed bituminous paving materials from a company certified by PennDOT to complete the tests required by this Specification supplied daily for each day bituminous material is delivered to the project site.

D. Material Certificates: Signed manufacturer certificates for each paving fabric shall be submitted for approval a minimum of seven (7) days prior to the pre-construction conference.

E. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver geotextile materials to the project site in original packaging with the manufacturer's labels containing the brand name and type of material. Store geotextile materials and other paving fabrics in accordance with Section 735 of PennDOT Publication 408 (most current revision).

B. The temperature of the hot mix asphalt paving material delivered to the project site shall not be below the minimum temperature shown on the material supplier's Bill of Lading and not above the maximum specified temperature. Material that fails to meet these criteria shall not be incorporated into the work and shall be removed from the project site.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply bituminous materials, geotextiles or paving fabrics until the following requirements are met:

1. The subbase or existing bituminous material is dry as determined by the Owner and/or Owner's Designated Representative.
2. The existing pavement has been prepared in accordance with Section 409 of PennDOT Publication 408 (most current revision).
3. Bituminous Base Course: Minimum surface and air temperature of 35 degrees Fahrenheit and rising at time of placement in accordance with Section 309 of PennDOT Publication 408 (most current revision). Do not place any base course mixtures from November 1 to March 31, unless an extension of the paving season, as specified in Section 409 of PennDOT Publication 408 (most current edition), is granted in writing by the Owner.
4. Superpave Bituminous Binder and Wearing Surface: Minimum surface and air temperature of 40 degrees Fahrenheit and rising at time of placement in accordance with Section 409 of PennDOT Publication 408 (most current revision). Do not place any binder or wearing course mixtures from November 1 to March 31, unless an extension of the paving season, as specified in Section 409 of PennDOT Publication 408 (most current edition), is granted in writing by the Owner.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. Coarse Aggregate: Shall conform to the requirements in Section 703 of PennDOT Publication 408 (most current revision).

B. Fine Aggregate: Shall conform to the requirements in Section 703 of PennDOT Publication 408 (current revision).

2.2 ASPHALT PAVING MATERIALS

A. Asphalt Cement: Shall conform to the requirements in Section 702 of PennDOT Publication 408 (most current revision) for AASHTO MP1, PG 64-22.

B. Tack Coat: Shall conform to the requirements in Section 460 of PennDOT Publication 408 (most current revision) for emulsified asphalt, Class AE-T.

C. Superpave Base, Binder and Wearing Surface: Superpave Asphalt Mixture Design, , PG 64-22, 0 to 0.3 million ESAL's, 9.5, 19.0 and 25.0 mm mix complying with the requirements in Section 409 of PennDOT Publication 408 (most current revision). The bituminous wearing surface shall incorporate coarse aggregate having a Skid Resistance Level (SRL) designation of "H" or better. Limit Recycled Asphalt Material (RAP) to a maximum of fifteen (15%) percent of the mixture by mass (weight).

D. Joint Sealant: Shall conform to the requirements for material in Section 469 of PennDOT Publication 408 (most current revision).

E. Source of Supply: Obtain all material from a source listed in PennDOT Bulletin 15 or PennDOT Bulletin 41 as applicable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subbase and existing bituminous paving is dry and in suitable condition to support paving and imposed loads.

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

3.2 REPAIRS

A. Scratch and Leveling Courses: Where indicated, place a separate scratch or leveling course ahead of resurfacing operations. Use a scratch course to fill wheel ruts and other local small depressions even with the surrounding pavement. Use a leveling course to provide a relatively uniform working platform for placing binder or wearing courses.

B. Asphalt Joint and Crack Sealing: Complete in accordance with Section 469 of PennDOT Publication 408 (most current revision).

3.3 SURFACE PREPARATION

A. General: Before delivering bituminous mixtures, remove and dispose of loose and foreign material and excess joint sealer and crack filler from the surface of existing pavement or previously placed pavement courses. In addition, verify that prepared subbase is ready to receive bituminous mixtures.

1. Removal of loose and foreign material shall be completed with a power broom or mechanical sweeper capable of collecting the material. All collected material shall be disposed of off the project site. If, in the sole opinion of the Owner or his designated Representative, cleaning is deemed inadequate, the Contractor shall repeat the procedure until it is deemed satisfactory at no additional cost to the Owner.
2. All joints in existing concrete pavements and all larger cracks in bituminous pavement (1/2" wide or larger) shall be thoroughly cleaned to a depth of one (1") inch and filled with an approved material.
3. The existing pavement surface shall be brought to a uniform grade and cross section as specified. The surface of the existing pavement shall be brought to the same transverse slope and longitudinal cross section as the finished pavement section using a scratch coat of bituminous binder at a variable thickness.

B. Tack Coat: Condition existing surface in accordance with Sections 409 of PennDOT Publication 408 (most current revision). Apply emulsified asphalt, Class AE-T as follows and in accordance with Section 460 of PennDOT Publication 408 (most current edition):

1. Use a distributor designed, equipped, calibrated, maintained, and operated to uniformly apply material on surfaces with varying widths and up to fifteen (15')-feet wide. Provide a distributor capable of maintaining a uniform distributing pressure and controlling the application rate within a tolerance of 0.02 gallons per square yard. Provide a distributor equipped with a tachometer, pressure gauges, accurate volume-measuring devices or a calibrated tank, a thermometer for measuring temperatures of tank contents, a power-operated pump, and full circulation spray bars with lateral and vertical adjustments.
2. Determine the distributor's application rate in the field according to PTM No. 747. Apply emulsified asphalt tack coat, at a rate approved by the Owner, Engineer and/or their designated Representative, to leave a uniform asphalt residue from 0.02 gallon per square yard to 0.07 gallon per square yard on the treated surface, as directed. Obtain approval of the application rate.
3. Apply the tack coat only when the air temperature is 40 degrees Fahrenheit and rising and when the existing surface is dry. Uniformly distribute the tack coat over the surface and as directed. Uniformly distribute the tack coat at the junction of adjacent applications. Tack all lifts unless directed otherwise.
4. Correct all uncoated or lightly coated areas to the Owner, Engineer and/or their designated Representative's satisfaction. At designated locations, correct areas with an excess of bituminous material by covering the area with sufficient dry fine aggregate to blot up or remove excess tack coat.
5. Allow the tack coat to cure, without being disturbed, until the Owner, Engineer and/or their designated Representative determines the water has completely separated and evaporated. Maintain and protect the treated surface against damage. Repair damaged areas to the Owner, Engineer and/or their designated Representative's satisfaction, at no additional cost to the Owner, before placing succeeding construction.
6. Tack coat shall be applied to all paving areas of the cartway, driveway edges, catch basins, inlets, manholes, curbs and utility boxes. The Contractor may use hand-spraying equipment in areas inaccessible to the distributor.

C. The Contractor shall check frames, covers, grates, water valve boxes and all other miscellaneous castings located in the proposed pavement area to insure that all such items have been accurately positioned and set to the proper slope and elevation after the subgrade and/or existing pavement surfaces have been prepared as specified herein, All frames, covers, grates, water valve boxes, and all other miscellaneous castings are to be set flush with the finished final pavement elevation. No depressions or mounds will be permitted in the pavement to accommodate inaccuracies in the setting of the listed appurtenances. All work that may be necessary to comply with above requirements shall be performed at the Contractor's sole cost and expense.

D. The Contractor shall line cut existing pavements with an approved pneumatic or mechanical cutting tool to create a vertical butting surface between the existing and new pavements where new pavements are to meet existing pavements. There shall be a one (1')-foot offset in each pavement course to permit each successive course to overlap the lower existing course. Line cutting of existing pavements shall be along neat, straight and even lines, and shall be performed in such a manner so as not to damage the adjacent pavement to remain. The Owner shall approve the acceptability of the line cutting device and the method of operation prior to new asphalt placement.

E. All vertical surfaces of curbs, structures, gutters, and existing pavement in contact with new bituminous mixtures shall be painted with a uniform coating of an approved bituminous emulsion or priming material. Extreme care shall be exercised in the application of this material to prevent splattering or staining of surfaces that are to remain exposed. Work that is stained as a result of the Contractor's operations shall be repaired and/or replaced at the Contractor's sole cost and expense.

F. The Contractor shall provide a milling machine designed and built for milling existing bituminous pavements with an automatic grade and slope control system and be capable of milling concrete patches for all proposed milling operations. The Contractor shall mill to provide a finished surface free from gouges, grooves and ridges and that conforms to the surface tolerance requirements of Section 409.3(l) of PennDOT Publication 408 (most current revision). Immediately after milling, remove milled material. When indicated that milled material is to be retained by the Contractor, satisfactorily dispose of milled material at an approved off-site facility off the Owner's property immediately after milling. When indicated that milled material is to be retained by the Owner, deliver milled material to the designated stockpiling location immediately after milling. Carefully remove the existing bituminous material around utility facilities within work areas. Repair or replace utility facilities damaged by the milling operation to the satisfaction of the Facility Owner at no additional cost to the Owner. Control the rate of milling to avoid tearing of the mat. If directed, separate oversized and chunky milled material. Maintain the milled surface free of all loose materials and dust. Place the first overlaying bituminous course within five (5) calendar days from the start of milling operations. Failure to overlay a milled section of roadway within five (5) calendar days will result in a penalty of five hundred ($ 500.00) dollars per calendar day until overlay operations begin. Work stoppages caused by the Owner, Facility Owners, and documented weather delays will not count towards the five (5) calendar days for calculating the penalty.

G. The Contractor shall cut or mill a keyway into the existing pavement to provide a tight, smooth joint. The keyway length shall be a minimum of fifteen (15) feet per inch of vertical change or as directed by the Owner.

3.4 HOT MIX ASPHALT PAVING EQUIPMENT

A. Hauling Equipment: Haul the mixtures in tightly sealed vehicles that do not contain petroleum oils, solvents, or other materials that adversely affect bituminous concrete. Provide covers of sufficient size and quality to protect the entire load under all conditions. Maintain the proper and uniform temperature specified in Section 409.3(h) 1 of PennDOT Publication 408 (most current edition). Provide insulation on all sides of the truck body, a double-walled truck body, or a heated truck body when the air temperature is below 50 degrees Fahrenheit from October 1 to April 30.

B. Bituminous Pavers: Provide self-contained, power-propelled units with activated screeds or activated strike-off assemblies and with automatic screed controls, capable of producing a finished surface of specified evenness and texture. Provide heated units capable of spreading and finishing the mixture to the widths and depths indicated. Provide units capable of being operated at forward speeds consistent with satisfactory placement of the mixture, equipped with receiving hoppers having sufficient capacity for uniform spreading, and equipped with distribution systems that place the mixture uniformly in front of the screeds. Use hydraulic or other extension types against abutting lanes or longitudinal joints only if the unit feeds and activates the extension by the same method as the main screed. At the outside edge of pavement widths that cannot be uniformly placed, the Contractor may use a non-activated extension when approved by the Owner, Engineer and/or their designated Representative. Do not use equipment that tears, shoves, or gouges the mixture, or that causes trucks, indented areas, flushing, segregation, or other permanent blemishes. Do not use graders or drags.

C. Rollers: Use steel-wheel, pneumatic tire, vibratory, or oscillating rollers as specified or allowed in Section 108.05(c)3 or 4 of PennDOT Publication 408 (most current edition). Operate rollers according to the manufacturer's recommendations. Use vibratory and oscillating rollers with separate controls for frequency and amplitude.

3.5 HOT MIX ASPHALT MATERIAL INSTALLATION

A. Place and compact bituminous paving mixtures during daylight hours in accordance with the Construction Details, PennDOT Publication 408 (most current edition) and in accordance with the following:

1. Do not place bituminous paving mixtures when the surfaces are wet or when the air or surface temperature is 40 degrees Fahrenheit or lower for binder and wearing courses and 35 degrees Fahrenheit or lower for base courses.
2. No paving mixture shall be installed if the temperature of the material is less than 265 degrees Fahrenheit or greater than 320 degrees Fahrenheit. All temperatures shall be shown on the Bill of Lading. If these requirements are not met, the bituminous material shall be rejected and removed from the project site.
3. All asphalt trucks are to remain covered and/or tarped until ready to dump into the paver. Any truck with an uncovered partial load waiting for unloading will not be permitted to dump into the paver.
4. If the indicated compacted depth of a course is more than six (6")-inches, place the HMA course in two or more layers of approximately equal compacted depth, with no layer less than three (3")-inches or more than six (6")-inches. For binder or leveling courses that have isolated areas exceeding six (6")-inches compacted depth, use a scratch or leveling course to eliminate the isolated areas before full-depth paving.

5. Immediately after placing the bituminous mixture, work the exposed outer edges to eliminate sharp, ragged, and open edges, to eliminate an unfinished appearance, and to reduce edge breakdown. Immediately repair edge breakdowns.
6. Do not allow vehicular traffic or loads on newly compacted courses for twenty four (24) hours or until the course uniformly cools to a temperature of 140 degrees Fahrenheit or less. Provide alternate routes as indicated or directed.
7. Do not use kerosene on paving equipment.
8. Seal overlay with PG 64-22 twelve (12")-inches wide with six (6")-inches on the overlay and six (6")-inches on the existing pavement.
9. A twelve (12")-inch pass of PG 64-22 shall be placed along concrete curbs and the gutter section of bituminous curbs. Sand gutter line when sealing past driveways and sidewalks and at all roadway joints in order to prevent tracking.
10. All sealing must be completed within two (2) working days after completion of asphalt placement.
11. In areas where mechanical spreaders cannot be used, place and screed the mixture with suitable hand tools. Do not use rakes.

3.6 JOINTS

A. Longitudinal Joints (General): Offset joints in a layer from the joint in the layer immediately below by approximately six (6")-inches. Plan joint location to ensure that the joint in the top layer is at the approximate pavement centerline for two-lane roadways and within twelve (12")-inches of the lane lines for roadways with more than two lanes. Avoid joint locations directly beneath planned pavement marking applications where possible.

Before placing abutting lanes, paint the entire area of the joint with a uniform coating of bituminous material, the PG binder used in the pavement course or PG 64-22. Painting of the joint is not required for scratch courses.

Place and compact the mixture according to the approved Paving Operation QC Plan (if applicable). Ensure the surface across the joint and along the joint is within the surface tolerances specified in Section 409.3(l) of PennDOT Publication 408 (most current edition).

Adhere to the following additional requirements for the construction of longitudinal joints:

1. Assure a true line when paving. Place and closely follow lines or markings for this purpose. When compacting loose mixture at an unsupported edge, make the first roller pass with the edge of the roller drum extending beyond and overhanging the unsupported edge by three (3") to six (6")-inches.
2. When placing uncompacted mixture adjacent to a previously compacted lane, operate the paver so that the material overlaps the edge of the previously placed lane by one (1") to one and one-half (1.5")-inches. Ensure that the mixture behind the screed is tightly pushed against the free face of the existing lane. Maintain the compacted mixture uniformly higher than the existing lane by at least one-quarter (1/4")-inch per inch of material being placed to assure full compaction. When possible, use automated joint matches when constructing joints between travel lanes. Do no bump back or lute the overlapped material unless overlap inadvertently exceeds the specified tolerances. When compacting loose mix at the longitudinal joint, keep the roller drum approximately six (6") to twelve (12")-inches from the joint for the first pass forward. On the backward and subsequent passes, overlap the joint two (2") to six (6")-inches. Ensure that the joint receives at least as many roller passes as the rest of the mat.
3. If traffic or other causes distort the lane edge, restore the lane edge to its original shape, using acceptable procedures.

B. Vertical joints:

1. The Contractor may use vertical joints for base, binder and wearing courses.
2. If traffic or other causes distort the lane edge, carefully saw a vertical lane edge before painting.
3. Place abutting lane on the same day, and if necessary, leave only short lane sections, normally less than twenty-five (25')-feet, where the abutting lane is not placed the same day.

C. Transverse Joints (General): Construct joints perpendicular to the pavement centerline. The Contractor may saw transverse joints. If used, install bulkheads straight and perpendicular to the surface. If a bulkhead is not used and the roller moves over the rounded edge of new mixture, locate the joint a sufficient distance from the rounded edge to provide a true surface and cross section. Paint the joint face with a thin coating of bituminous material, the PG binder used in the pavement course or PG 64-22, before placing fresh mixture against the joint face. Painting of the joint face is not required for scratch courses.

D. Seal joints with hot bituminous material of the class and type designated for the wearing course or use a Class AET, Class E-6 (AASHTO SS-1 or CSS-1) or E-8 (AASHTO SS-1h or CSS-1h) emulsified asphalt instead of hot bituminous material. Seal at the following locations under the following conditions:

1. All edges of the new pavement, including around inlet, manhole and utility box castings.
2. On pavements with bituminous wedge curbs, apply eight (8")-inches of sealant on the lane and four (4")-inches on the wedge curb.
3. On pavements with concrete curbs, apply ten (10")-inches of sealant on the lane and two (2")-inches on the inside face of the curb.
4. Sand all joints at driveways and sidewalks to prevent material tracking.
5. Seal all joints within two (2) working days of completion of asphalt placement.

3.7 COMPACTION

A. Compact the mixture to achieve the density acceptance requirements and to eliminate all roller marks. Compact the mixture while it is in proper condition and adjust roller speed, amplitude, frequency, pattern, and roller size to eliminate displacement, shoving, cracking, and aggregate breakage. Satisfactorily correct displacement resulting from reversing roller directions and other causes.

B. Without using excess water, maintain wheels of steel-wheel rollers moist and clean to prevent the mixture from adhering to the wheels. Use suitable methods to clean wheels of pneumatic-tire rollers. Use pneumatic-tire rollers for compacting scratch courses.

C. For areas inaccessible to rollers, compact with mechanical vibrating hand tampers.

D. Remove areas that are loose, broken, mixed with dirt, or show an excess or deficiency of bituminous material. Replace removed mixture with fresh hot mixture and compact the entire mixture even with the surrounding pavement surface.

E. Do not allow vehicular traffic or loads on newly compacted courses for twenty four (24) hours or until the course uniformly cools to a temperature of 140 degrees Fahrenheit or less. Provide alternate routes as indicated or as directed. If both lanes that form a longitudinal joint are placed on the same day and public safety is not restricted, do not allow vehicular traffic or loads on the lanes until adequate stability and adhesion is obtained and the material has uniformly

cooled to 140 degrees Fahrenheit or less. Maintain the course as specified according to Sections 105.13, 107.15 and 901 of PennDOT Publication 408 (most current edition).

3.8 INSTALLATION TOLERANCES

A. Depth: In accordance with Sections 309 and 409 of PennDOT Publication 408 (most current revision).

1. Base Course: Control the loose depth of each layer to construct the base course to the compacted depth indicated and within the specified tolerance. On the top lift and in the presence of the Owner, Engineer and/or their designated Representative, drill full-depth cores at one random location selected by the Owner, Engineer and/or their designated Representative according to PTM No. 1 in each 2,000 square yards of completed base course and at other locations the Owner, Engineer and/or their designated Representative suspects are deficient. The Owner, Engineer and/or their designated Representative will measure the full-depths cores according to PTM No. 737. Pavement deficient in depth by one-half (1/2") inch or more and that cannot be satisfactorily corrected is defective. After the Owner, Engineer and/or their designated Representative completes depth measurements, backfill, compact, and seal core holes with the mixture used to construct the course. Immediately start correcting courses or pavement that are deficient in depth at the core location and proceed longitudinally and transversely until the depth is within one-half (1/2") inch of the design depth.
2. Binder and Wearing Courses: Construct the pavement to the depth indicated and within the specified tolerances. For courses with density acceptance by lots, follow the above procedure except that pavement deficient in depth by one-quarter (1/4")-inch or more is defective work. Pavement deficient in depth by more than one-eighth (1/8")-inch in three (3) or more adjacent core locations is defective work. For courses with a designed course depth and density acceptance by non-movement or optimum rolling pattern, the Owner, Engineer and/or their designated Representative will calculate the weight per square yard for verification of yield. If yield results indicate insufficient course depth, drill one (1) six (6")-inch core for each 165 tons of material placed to determine the extent of the deficient depth. Core locations will be determined using PTM No. 1. Follow the above procedures for backfill cores and correcting deficient courses or pavements.

B. Surface Tolerance: Test the finished surface with a ten (10)-foot straightedge at areas the Owner, Engineer, and/or their designated Representative determines may be deficient or irregular, and at transverse joints and paving notches. Hold the straightedge in contact with the surface and in successive positions parallel to the road centerline to check the entire width of the pavement. Advance along the pavement in stages of not more than one-half the length of the straightedge until the entire area is tested. The pavement is defective if irregularities are more than three-sixteenths (3/16")-inch for binder and wearing courses and one-quarter (1/4")-inch for base courses.

C. Crowned Surfaces: Test using appropriate instruments and procedures acceptable to the Owner to insure the required cross section ("crown") is obtained.

3.9 MAT DENSITY ACCEPTANCE

A. With the Owner, Engineer and/or their designated Representative and the Contractor's certified HMA field technician present, determine density with an approved nuclear gauge according to PTM No. 402. Nuclear gauges must be operated by a licensed nuclear gauge operator. In the presence of the Owner, Engineer and/or their designated Representative, establish the optimum-rolling pattern for each course according to PTM No. 402. Document optimum-rolling

patterns using Form TR-4276-B and provide the completed forms to the Owner, Engineer and/or their designated Representative. Compact the course according to the optimum-rolling pattern. During paving, the Owner, Engineer and/or their designated Representative may require the Contractor to verify the target density established by the optimum-rolling pattern. If the target density is not achieved, establish a new optimum-rolling pattern as directed. The Owner, Engineer and/or their designated Representative may suspend paving when the optimum-rolling pattern is not being followed.

3.10 MIXTURE ACCEPTANCE SAMPLES

A. After JMF verification, sample and test the mixture according to the approved QC Plan. For daily production of each JMF greater than fifty (50) tons, determine asphalt content, gradation, and theoretical maximum specific gravity from the same sample at least once each day. For daily production of each JMF greater than one hundred fifty (150) tons, determine asphalt content, gradation, theoretical maximum specific gravity and perform volumetric analysis of compacted specimens from the same sample as least once each day. Provide daily test results to the Owner, Engineer and/or their designated Representative.

B. In the presence of the Owner, Engineer and/or their designated Representative, obtain one (1) loose mixture sample from the uncompacted mixture placed by the paving equipment specified elsewhere and immediately package. Test as required per Section 409.2.c.1 and report results to Owner, Engineer and/or their designated Representative.

END OF SECTION 321216

SECTION 321313 – CONCRETE PAVING

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 exterior cement concrete pavement for the following:

1. Curbs
2. Sidewalks
3. Driveways
4. Concrete Encasement

B. Related Sections include the following:

1. Section 312000 "Earth Moving" for subgrade preparation, grading, and subbase course.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

B. PennDOT: Pennsylvania Department of Transportation.

1.4 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Qualification Data: For manufacturer.

D. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

E. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

F. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" or approved PennDOT batch plant.

2. On-site batching of concrete will not be permitted.

B. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

C. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

1.6 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

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. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. 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.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

1. Use flexible or curved forms for curves with a radius one hundred (100') feet or less.

2. Forms shall be of metal or new wood at least ten (10') feet long.

3. Wood forms shall be rigid enough not to bow and deflect when concrete is placed. Worn, broken or distorted forms shall not be used.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

C. Each form shall be braced and staked in at least three (3) places for each ten (10') foot length, closer if necessary to keep from deforming when concrete is placed.

D. Forms must extend the full depth of the concrete curb, sidewalk or driveway.

E. The entire front and rear face of the curb must be formed. No wild pours or partial forming will be allowed.

2.3 STEEL REINFORCEMENT

A. The Contractor shall submit data sheets for all steel reinforcement.

2.4 CONCRETE MATERIALS AND MIXTURES

A. Cementitious Material: Use one of the following cementitious materials, of the same type, brand, and source throughout the project:

1. Portland Cement: ASTM C 150, Type I, non-air Entraining Portland Cement.

B. Normal Weight Aggregates: ASTM C 33 coarse aggregate or better, graded. Provide aggregates from a sole source with documented service record data of at least ten (10) years satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate: Crushed and graded limestone for reinforced concrete pavement, concrete curb, concrete sidewalk, reinforced concrete drives and any exposed concrete in structures.
2. Fine Aggregate: Type A aggregate.

C. Water: ASTM C 94/C 94M.

D. Twenty-eight (28)-day strength: 4000 psi.

E. Slump shall be four (4")-inches plus or minus one (1")-inch.

F. Air Entraining Admixtures shall be in accordance with AASHTO Designation M-154 (ASTM C-260-01)

G. Entrained air content shall be 5.0% with a tolerance of plus or minus 1.0%

H. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience. To obtain approval, the mix design must be submitted two (2) weeks before contemplated use.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.

I. All site concrete shall meet or exceed the above criteria or be approved PennDOT Class AAA concrete.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz. /sq. yd. dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Curing Compound: ASTM C 309, Type 1, Classes A and B; ASTM C 1315, Type 1, Class A; and AASHTO M 148, Type 1 Classes A and B. Must meet US EPA maximum allowable VOC requirements.

2.6 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber (AASHTO–M213)

B. Concrete Joint Sealant: Sikaflex-1A (or approved equal). The sealant shall be a one-part polyurethane, elastomeric sealant/adhesive meeting Federal Specification TT-S-00230C, Type II, Class A and ASTM C-920, Type S, Grade NS, Class 35 use T, NT, O, M, G and I. Color shall be limestone or as chosen by the Owner.

C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to requirements, and as follows:

1. Types I and II, non-load bearing or IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

D. Silane-based Water Repellent: Use water repellent meeting the performance standards of NCHRP 244 with a minimum percent solids of forty (40%) percent. Prepare surface and apply according to manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrade and subbase for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subgrade surface with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding as follows or as dictated by field conditions:

1. Completely proof-roll subgrade in one direction and repeat in perpendicular direction. Limit vehicle speed to three (3) mph.
2. Proof-roll with a loaded tandem-axle dump truck weighing not less than fifteen (15) tons.
3. Subgrade with soft spots and areas of pumping or rutting exceeding depth of one-half (1/2”)-inch shall be repaired prior to placement of concrete.
4. Concrete curb and sidewalk subbases shall be compacted using a mechanical whacker to seventy (70%) relative density per ASTM D 4253 and ASTM D 4254.

C. Proceed with concrete pavement operations only after non-conforming conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

B. The subgrade shall be compacted to ninety-five (95%) modified Proctor at the optimum moisture content per ASTM D 1557.

C. Concrete slabs shall be a minimum of eight (8”) inches thick for roadways, six (6”) inches thick for driveways and four (4”) inches thick for sidewalks. The aggregate bed shall be a minimum of six (6”) inches thick for roadways and four (4”) inches thick for driveways and sidewalks. The aggregate bed shall be AASHTO #57 crushed limestone aggregate.

3.3 SUBGRADE REPAIR

A. After the existing pavement and subbase have been removed to subgrade, the Owner will determine if soft spots exist and, if so, mark the limits of soft spots to be replaced.

B. If soft spots are marked, the Contractor shall excavate and replace unsuitable materials with a minimum of twelve (12”) inches of AASHTO No.1 limestone aggregate with a two (2”) inch PennDOT 2A limestone aggregate “choke” placed over PennDOT Class 4, Type A fabric. The fabric shall wrap over the top of the placed aggregate prior to the placement of the required aggregate subbase. All unsuitable materials shall be removed from the site at no additional cost to the Owner. Payment for soft spot repair shall be by Bid Unit price or per applicable Contract provisions.

3.4 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least twenty (24) hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.5 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement. Provide chairs to retain reinforcing elevations. Contractors will not be permitted to place reinforcing and then pull-up as the pour progresses.

D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum two (2”)-inch overlap of adjacent mats.

Concrete slabs shall be constructed per PennDOT Publication 408 (most current edition), PennDOT RC standards and applicable plan Details.

3.6 JOINTS

A. Line / control joints in slabs and curbs shall be placed at intervals equal to the pavement width not to exceed twelve (12’) feet.

B. Expansion joints in slabs and curbs shall be placed at fifty (50’) foot maximum intervals.

C. Joints shall be completed by using a grooving tool or by saw-cutting to a depth of twenty-five (25%) percent of the slab thickness to a minimum depth of one (1”). All cuts shall be completed within twenty-four (24) hours from initial placement of concrete.

3.7 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at project site.

F. Do not add water to fresh concrete after testing.

G. No vehicles and/or equipment shall be placed or moved on concrete pavement until fourteen (14) days have elapsed from time of pour and then only after earth shoulders are placed against the pavement edges.

H. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

I. The crown in any pavement or base shall be measured from the high side edge where one edge is higher than the other except where otherwise noted.

J. Screed pavement surfaces with a straightedge and strike off.

K. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

L. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.

M. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below forty (40) degrees Fahrenheit, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than fifty (50) degrees Fahrenheit and not more than eight (80) degrees Fahrenheit at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.

N. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below ninety (90) degrees Fahrenheit at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete will be at Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.8 CONCRETE SIDEWALKS

A. Forms shall be of metal or new wood at least ten (10') feet long. Each form shall be braced and staked in at least three (3) places for each ten (10') foot length and closer if necessary to keep from deforming when concrete is placed. They shall be thoroughly cleaned and coated with non-staining oil. Wood forms shall be rigid enough not to bow and deflect when concrete is placed. Worn, broken or distorted forms shall not be used.

B. The sidewalks proposed to be disturbed due to a construction shall be saw cut prior to excavation. Saw cutting shall be included in the price of the sidewalk restoration and no additional compensation will be provided for the saw cutting.

C. Contraction joints shall be spaced at a minimum of five (5) foot intervals and formed with a device to have the completed joint at least one-half (1/2")-inch deep. Expansion joints shall be spaced no more than twenty (20') feet apart and formed with one-quarter (1/4")-inch pre-molded filler to the full depth of the slab. The pre-molded filler shall also be placed adjacent to curbs, other sidewalks, buildings or pavement. If the sidewalk abuts a curb, the joints on the sidewalk shall match the joints in the curb.

D. Concrete sidewalks shall be reinforced with 6x6 – W2.9 x W2.9 wire mesh with a minimum cover of two (2") inches and three (3") inches respectively.

E. The surface of the slab shall be brought to a uniform plane surface by means of a wood screed riding on forms. The surface shall then be finished with a wood or magnesium float and fine broom finished. The tool marks for joints and edges shall match the marks in the existing walk. Neither dry cement nor water shall be added to the surface during the finishing process.

F. On any tooled joints or edges of concrete do not use the jointing or edging tool until the surface water has evaporated from the concrete. Bull float and broom the surface, then finish the joint and edges and use the broom to remove the tool marks on the surface.

G. After twenty-eight (28) days (or as recommended by the manufacturer or directed by the Owner), apply an approved silane sealer.

H. The concrete shall be thoroughly vibrated to eliminate voids within the placed concrete.

I. Insulated protection of the concrete shall be required dependent on weather conditions at the time of pouring and during the curing period. A polyethylene plastic sheeting shall be considered as the adequate minimum protection required for concrete during adverse weather conditions. The Owner reserves the right to require additional protective measures such as blanketing. No additional compensation will be considered in the event protective measures above the minimum are required by the Owner.

J. Replace rain conductors in kind if found under a sidewalk. Place a piece of No. 9 gauge wire mesh reinforcing one (1') foot over the pipe for reinforcement. In addition, a construction joint shall be placed over the rain conductor location. No additional compensation will be considered for the removal and/or replacement of roof or driveway drains under a sidewalk.

K. Restore and/or raise to grade all gas valves, water valves, sewer vents, or other utility valve boxes encountered during driveway restoration. No additional compensation will be considered for work associated with this requirement.

3.9 CONCRETE CURB RESTORATION

A. The Contractor shall be required to replace damaged concrete straight curb, curb and gutter or roll curb. Straight curb shall be replaced in kind at the same width as was removed. No additional compensation will be granted relative to the width of the curb. The straight curb shall be installed in accordance with the detail provided.

B. Private concrete curb disturbed during construction shall be replaced in kind and in accordance with the Detail provided.

C. Curbs proposed to be disturbed during construction shall be saw cut prior to excavation. Saw cutting shall be included in the price of the curb restoration and no additional compensation will be considered for saw cutting.

D. Forms shall be of metal or new wood at least ten (10') feet long. Each form shall be braced and staked in at least three (3) places for each ten (10') foot length and closer if necessary to keep from deforming when concrete is placed. They shall be thoroughly cleaned and coated with non-staining oil. Wood forms shall be rigid enough not to bow and deflect when concrete is placed. Worn, broken or distorted forms shall not be used.

E. Effort shall be made to minimize damage to curbs.

F. The Contractor shall be responsible for providing AASHTO #57 crushed limestone for a suitable base for the curb in accordance with the Detail.

G. A 2-ply tar paper must be placed between the AASHTO base and the concrete curb.

H. Control joints shall be placed at ten (10) feet on center.

I. Expansion joints shall be spaced no more than fifty (50') feet apart and formed with one-quarter (1/4") inch pre-molded filler to the full depth of the slab. The pre-molded filler shall also be placed adjacent to curbs, other sidewalks, buildings or pavement. If the curb abuts a sidewalk, the joints on the curb shall match the joints in the sidewalk.

J. A six (6") inch minimum diameter SLCPP perforated underdrain may be placed under the curb in accordance with the Detail and connected to the storm sewer system as directed by the Owner.

K. The concrete shall be thoroughly vibrated to eliminate voids within the placed concrete.

L. The finish on the concrete shall match the finish of the existing curb.

M. After twenty-eight (28) days (or as recommended by the manufacturer or directed by the Owner), apply an approved silane sealer.

N. If any rain conductors exist through the curb, they shall be replaced in kind. No additional compensation will be provided for the restoration of roof/driveway drains through the curb.

O. Insulated protection of the concrete shall be required dependent on weather conditions at the time of pouring and during the curing period. A polyethylene plastic sheeting shall be considered as the adequate minimum protection required for concrete during adverse weather conditions. The Owner reserves the right to require additional protective measures such as blanketing. No additional compensation will be considered in the event protective measures above the minimum are required by the Owner.

3.10 CONCRETE ENCASEMENT FOR UTILITIES

A. Under this item the Contractor shall be required, if necessary, and as approved by the Owner in writing, to install concrete encasement around utility lines that are exposed within twelve (12") inches of a proposed sewer.

B. Installation of concrete encasement shall be completed with an eight (8') inch minimum bed of air entrained 4000 psi high early strength concrete (HES) placed below an existing utility line. The concrete must then extend up the sides of the utility line and placed to a minimum depth of at least eight (8") inches above the utility line.

C. The concrete shall be allowed to cure for a minimum of twenty-four (24) hours prior to backfilling. The Owner reserves the right to extend the curing period until the concrete has cured sufficiently so that the encasement does not become damaged during backfilling. The curing period may vary depending on weather conditions.

D. The Contractor shall use caution during backfilling to prevent damage to the concrete encasement.

E. The Contractor shall be required to take all necessary precautions for curing concrete in hot and/or cold weather at no additional cost to the Owner.

3.11 FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations.

C. The surface of concrete sidewalks shall be brought to a uniform plane surface by means of a wood screed riding on forms. The surface shall then be finished with a wood or magnesium float and stiff textured broom finished perpendicular to line of traffic. The tool marks for joints and edges shall match the marks in the existing walk. Neither dry cement nor water shall be added to the surface during the finishing process.

D. The portion of the curb to be exposed to the elements shall be finished smooth with a wood or magnesium float. All minor defects shall be filled with cement mortar. No watered brush finish or plastering of the curb will be permitted. All joints and exposed edges shall be tooled to a radius of one quarter (1/4") inch. No tool marks will be permitted to show on the finished curb. Final finish shall be made with a coarse broom.

E. The surface of the concrete driveway slab shall be brought to a uniform plane surface by means of a wood screed riding on forms. The surface shall then be finished with a wood or magnesium float and fine broom finished. The tool marks for joints and edges shall match the marks in the existing driveway. Neither dry cement nor water shall be added to the surface during the finishing process.

F. On any tooled joints or edges of concrete do not use the jointing or edging tool until the surface water has evaporated from the concrete. Bull float and broom the surface, then finish the joint and edges and use the broom to remove the tool marks on the surface.

3.12 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 pounds per square foot by depth before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

3.13 CONCRETE JOINT SEALING

A. All expansion joints and joints against structures shall be sealed.

B. The sealant shall be “Sikaflex-1A Polyurethane, Elastomeric Sealant/Adhesive” (or Owner approved equal). Sealant color shall be selected by the Owner from the range of available colors prior to application.

C. All joints must be sound, clean, dry and free from oil and grease. Curing compound residues and any foreign material must be thoroughly removed. Install bond breaker tape or backer rod to prevent bond at the base of the joint.

D. Apply Sikaflex-1A at a temperature between forty (40) degrees Fahrenheit and one hundred (100) degrees Fahrenheit with a gun using the twenty (20) ounce “uni-pac” sausage. Follow manufacturer’s written instructions.

3.14 CONCRETE SEALING

A. General: Concrete shall be cured or aged twenty-eight (28) days prior to sealer application.

B. Surface shall be cleaned and dried. Any curing compounds, form release agents and any other contaminants shall be removed per the material manufacturer.

C. Mask or otherwise protect any adjacent surfaces which are not to have sealer applied.

D. Apply sealer with a method approved by the manufacturer. Apply two coats (or as recommended by the manufacturer) to ensure even coverage.

3.15 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:

1. Elevation: 1/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot long, unleveled straightedge not to exceed 1/4 inch.
4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch.
6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.
8. Contraction Joint Depth: Plus 1/4 inch, no minus.
9. Joint Width: Plus 1/8 inch, no minus.

3.16 BACKFILLING

A. The Contractor shall not backfill against walks, driveways, curbs, etc. until concrete forms have been removed, concrete cured and written authorization has been given by the Owner. All debris shall be removed from top to bottom of all excavations prior to all backfilling operations. In lawn or ground covers areas, backfilling shall be done with clean earth placed in six (6') inch compacted layers.

3.17 TESTING

A. The Contractor shall engage a qualified professional to perform concrete testing. All results shall be forwarded to the Owner for review.

B. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one (1) composite sample for each day's pour of each concrete mixture exceeding five (5) cubic yards but less than twenty-five (25) cubic yards plus one set for each additional fifty (50) cubic yards or fraction thereof.

2. Testing Frequency: Obtain at least one (1) composite sample for each one hundred (100) cubic yards or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five (5) compressive-strength tests for each concrete mixture, testing shall be conducted from at least five (5) randomly selected batches or from each batch if fewer than five (5) are used.

3. Slump: ASTM C 143/C 143M; one (1) test at point of placement for each composite sample, but not less than one (1) test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

4. Air Content: ASTM C 231, pressure method, for normal-weight concrete; (ASTM C 173/C 173M, volumetric method, for structural lightweight concrete) one (1) test for each composite sample, but not less than one (1) test for each day's pour of each concrete mixture.

5. Concrete Temperature: ASTM C 1064/C 1064M; one test (1) hourly when air temperature is 40 degrees Fahrenheit and below and when air temperature is 80 degrees Fahrenheit and above, and one (1) test for each composite sample.

6. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one (1) test for each composite sample, but not less than one (1) test for each day's pour of each concrete mixture.

7. Compression Test Specimens: ASTM C 31/C 31M.

    a. Cast and laboratory cure two (2) sets of two (2) standard cylinder specimens for each composite sample.
    b. Cast and field cure two (2) sets of two (2) standard cylinder specimens for each composite sample.

8. Compressive Strength Tests: ASTM C 39/C 39M; test one set of two (2) laboratory cured specimens at seven (7) days and one set of two (2) specimens at twenty-eight (28) days.

    a. Test one (1) set of two (2) field-cured specimens at seven (7) days and one (1) set of two (2) specimens at twenty-eight (28) days.
    b. A compressive-strength test shall be the average compressive strength from a set of two (2) specimens obtained from same composite sample and tested at age indicated.

9. When strength of field-cured cylinders is less than eighty-five (85%) percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

10. Strength of each concrete mixture will be satisfactory if every average of any three (3) consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than five hundred (500) psi.

11. Test results shall be reported in writing to Owner, concrete manufacturer, and Contractor within forty-eight (48) hours of testing. Reports of compressive-strength tests shall contain project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at twenty (28) days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both seven (7)- and twenty-eight (28)-day tests.

12. Non-destructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Owner but will not be used as sole basis for approval or rejection of concrete.

13. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Owner. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Owner.

14. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

15. Correct deficiencies in the Work indicated by insufficient results shown by testing and/or inspection at no additional cost to the Owner.

3.18 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.

B. Drill test cores, where directed by Owner, 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 fourteen (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 (2) days before date scheduled for Substantial Completion inspection or as directed by the Owner.

END OF SECTION 321313

SECTION 321723 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section describes the application of painted pavement markings, marker tape, and reflective markers, and the removal of existing markings.

1.3 REFERENCES

A. PennDOT: Pennsylvania Department of Transportation, Publication 408 (most recent version).

1. PennDOT Section 960 – Hot Thermoplastic Pavement Markings
2. PennDOT Section 961 – Cold Plastic Markings or Legends
3. PennDOT Section 962 – Waterborne Pavement Markings
4. PennDOT Section 963 – Pavement Marking Removal
5. PennDOT Section 964 – Epoxy Pavement Markings
6. PennDOT Bulletin 15 (Publication 35) – Qualified Products List for Construction.

PART 2 - PRODUCTS

2.1 PAINT

A. Provide waterborne marking paint listed on PennDOT Bulletin 15 in conformance with PennDOT Section 962 and the following:

1. White: Ennis-Flint Paint No. 991022 or 991152
2. Yellow: Ennis- Flint Paint No. 991028 or 991158
3. Approved equal.

2.2 STENCILS

A. Provide stencils made from 1/2-inch exterior grade plywood or other approved means.

2.3 TEMPORARY MARKING TAPE

A. Provide foil-backed temporary pavement marking tape manufactured by 3M, or equal.

2.4 GLASS BEADS

A. In accordance with PennDOT Section 1103.14. Follow manufacturer's recommendations for bead gradation, coating, and drop rate.

PART 3 - EXECUTION

3.1 REMOVAL OF EXISTING PAVEMENT MARKING

A. Remove existing marking not required as part of finish marking layout.

B. Remove paint down to pavement surface by sandblasting, water-blasting, shot steel, or other approved means. Removal method shall not damage pavement surface.

C. If chemical solvents are used, submit Safety Data Sheets (SDS) and manufacturer's material information to the Port at least three days prior to their application. Chemicals and application methods shall not be harmful to the environment.

3.2 WEATHER LIMITATIONS

A. Perform painting, temporary marking, and taping only when:

1. Existing surfaces are dry and clean.
2. The ambient temperature is above 40ºF (50ºF if water-based paint is specified) and no greater than 95ºF. Maintain paint temperatures within the same limits.
3. Weather conditions are not excessively windy, dusty, or foggy. Weather suitability will be determined by the Owner.

3.3 TRAFFIC CONTROL

A. Per approved Traffic Control Plan, PennDOT Publications 213 and 236 and all applicable City of Pittsburgh traffic control publications.

3.4 EQUIPMENT

A. Equipment necessary for satisfactory completion of the work includes apparatus to properly clean pavement surfaces, mechanical marking devices, and auxiliary hand-painting equipment. Obtain the Owner's approval of equipment prior to use.

B. Provide adequate stand-by equipment in the event of equipment failure when the possibility of delay of traffic or operations exists.

3.5 LAYOUT AND ALIGNMENT

A. Provide layout and alignment markings necessary to establish permanent striping as indicated on the Drawings and as follows:

1. Provide temporary paint markings for pavement marking layout.

3.6 MARKING TAPE INSTALLATION

A. Temporary Marking Tape

1. Apply tape for temporary lane lines until the application of paint markings has been accomplished.

B. Permanent Marking Tape

1. Apply marking tape at intersections to provide guidance through the intersection.

3.7 PREPARATION OF EXISTING SURFACE

A. Immediately prior to application of paint, clean pavement of dirt, rust, grease, oil, acids, or other foreign matter which may reduce paint bond to the pavement.

B. Scrub areas which cannot be satisfactorily cleaned by brooming and blowing with a solution of water and trisodium phosphate (10% Na3PO4 by weight), or equal. Rinse cleaned areas of solution and foreign matter. Dry before painting.

3.8 PAINT APPLICATION

A. Wait a minimum of two (2) weeks from installation of pavement surface course to paint marking, unless otherwise directed by the Owner.

B. Apply paint markings in accordance with dimensions, locations, and spacings shown on the Drawings, unless otherwise approved by the Owner.

C. Apply paint only to a dry surface.

D. Apply paint only after the Owner approves layout and surface conditions.

E. Thoroughly mix paint in strict accordance with the manufacturer’s written instructions before and during application. Apply paint at its original consistency without the addition of thinners.

F. Apply paint uniformly, with suitable equipment, at rates of not less than one hundred five (105) nor more than one hundred fifteen (115) square feet per gallon or as recommended by the manufacturer.

G. Deviations in the edges of straight stripes exceeding 1/2-inch in 50 feet shall be removed and the marking corrected. The width of the markings shall be as designated on the Drawings, within a tolerance of five (5%) percent. Perform painting in a neat and workmanlike manner to the satisfaction of the Owner.

H. Paint shall not bleed or discolor when in contact with bituminous materials.

I. Apply glass beads uniformly by suitable equipment at a rate of not less than five (5) pounds per gallon of paint.

3.9 PROTECTION

A. Protect striping and other markings from damage of any kind while the paint is drying. Protect paint from disfigurement by traffic, spatter, splashes, spillage, drippings, weather, etc. Place suitable warning signs, cones, flags, barricades, or protective screens as required.

END OF SECTION 321723

SECTION 321726 - TACTILE WARNING SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Americans with Disabilities Act (ADA) Title 49 CFR Transportation, Part 37.9 Standards for Accessible Transportation Facilities, Appendix A, Section 4.29.2 Detectable Warnings on Walking Surfaces.

C. FHA Memo (5-06-02) titled Truncated Domes.

D. Federal Register Volume 71, No. 209, 49 CFR Part 37 (10-30-06)

E. ADA Standards for Transportation Facilities (11-29-06, DOT): Sections 406, 705, and 810.

F. ADA Standards for Accessible Design – 2010 (9/05/11, DOJ)

G. ADAAG: Sections 705 and 810. Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Rights of Way (7/23/11, Access Board), PROWAG: Sections R208, R304, R305, R308, and R309.

H. American Society for Testing and Materials (ASTM) Test Methods B 117, C 501, C 1028, D 543, D 570, D 638, D 695, D 790, G 151, G 155, and E 84.

I. American Association of State Highway and Transportation Officials (AASHTO): Test Method AASHTO-H20.

1.2 SUMMARY

A. Section Includes:

1. Cast in Place detectable warning tiles.

B. Related Requirements:

1. Section 321313 "Concrete Paving".

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, submit manufacturer's literature describing products.

B. LEED Submittals:

1. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.

C. Shop Drawings: For each type of tactile warning surface.

1. Submit standard manufacturer shop drawings showing all pertinent characteristics, including profile, sound on cane contact amplification feature, and installation methods.

1.4 INFORMATIONAL SUBMITTALS

A. Material Test Reports:

1. Submit current test reports from qualified, accredited independent testing laboratory in accordance with ASTM guidelines and indicating that materials proposed for use are in compliance with specification requirements and the meet properties indicated.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For tactile warning surfacing, to include in maintenance manuals.

1. Maintenance Instructions: Include copies of manufacturer's specified maintenance practices for each type of tactile warning surface tiles and accessories.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Experienced installer, certified in writing by tactile warning surface manufacturer, who has successfully completed tactile warning surface installations similar in material, design, and extent to work in project.

1.7 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Mortar and Grout:

1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Provide artificial shade and windbreaks, and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 degrees Fahrenheit and higher.

1.8 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of tactile warning surfaces that fail in materials within specified warranty period.

1. Warranty includes: manufacturing defects, breakage, and deformation.

2. Warranty Period: Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TACTILE WARNING SURFACING, GENERAL

A. Accessibility Requirements: Comply with the American Disabilities Act Accessibility Guideline (ADAAG), Public Right-of-Way (PROW) and California Title 24 Requirements.

1. For tactile warning surfaces composed of multiple units, provide units that when installed provide consistent side-to-side and end-to-end dome spacing that complies with requirements.

B. Source Limitations: Obtain each type of tactile warning surfacing, joint material, setting material, anchor, and fastener from a single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. Compliance: Tactile Warning Surface.

1. Compliant with ADA requirements.

2. Water Absorption: Not to exceed 0.20 percent, when tested in accordance with ASTM D 570.
3. Slip Resistance: 0.80 minimum combined wet/dry static coefficient of friction, when tested in accordance with ASTM D 695.
4. Compressive Strength: 25,000 psi minimum, when tested in accordance with ASTM C 1028.
5. Tensile Strength: 10,000 psi minimum, when tested in accordance with ASTM D 638.
6. Flexural Strength: 25,000 psi minimum, when tested in accordance with ASTM D 790.
7. Chemical Stain Resistance: No reaction to one (1%) percent hydrochloric acid, motor oil, calcium chloride, gum, soap solution, bleach, and antifreeze, when tested in accordance with ASTM D 543.
8. Abrasion Resistance: 300 minimum, when tested in accordance with ASTM C 501.
9. Flame Spread: 25 maximum, when tested in accordance with ASTM E 84.
10. Accelerated Weathering: ΔE less than 5.0 at 2,000 hours minimum exposure, when tested by ASTM G 155 or ASTM G 151.
11. AASTHO_H20 Load Bearing Test: No damage at 16,000 pounds loading.
12. Salt and Spray Performance: No deterioration or other defects after 200 hour of exposure, when tested in accordance with ASTM B 117.

2.3 CAST IN PLACE TACTILE SURFACE

A. Cast in Place Tactile Surface: Accessible truncated-dome cast in place tactile surface configured for setting flush in new concrete walkway surfaces, ramps, or new construction with slip-resistant surface treatment on domes and field of tile. Cast in Place Tactile Surfaces have a 1/4 inch nominal thickness and feature embedment ribs 3 inches on center through entire length of tile.

1. Basis-of-Design Product: Subject to compliance with requirements, provide ADA Solutions, Inc.; Cast in Place Tactile Surface or comparable product by one of the following:

    a. Detectile, Inc.
    b. Approved Equal.

2. Material: Homogeneous glass and carbon composite material which is colorfast and UV stable.

3. Color: Uniform throughout, and not reliant on any type of paint coating to achieve color stability. Federal Yellow (Y) per Federal Standard 595B Table IV, Color No. 33538.

4. Shapes and Sizes:

    a. Rectangular panel, 2.35 inch dome spacing; 24 by 48 inches.

5. Mounting:

    a. Permanently embedded detectable warning surface wet-set into freshly poured concrete.

2.4 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of tactile warning surfaces, noncorrosive and compatible with each material joined, and complying with the following:

1. Furnish color appropriate nylon sleeve, stainless-steel fasteners for exterior use.
2. Fastener Heads: For nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant heads, colored to match tile.

B. Adhesive: As recommended by manufacturer for adhering tactile warning surfacing unit to substrate.

C. Sealant: As recommended by manufacturer for sealing perimeter of tactile warning surfacing unit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that concrete is in suitable condition to begin installation according to manufacturer's written instructions. Verify that installation of tactile warning surfacing will comply with accessibility requirements upon completion.

3.2 INSTALLATION OF TACTILE WARNING SURFACING

A. General: Prepare substrate and install tactile warning surfacing according to manufacturer's written instructions unless otherwise indicated.

B. Place tactile warning surfacing units in dimensions and orientation indicated in Contract Documents.

3.3 CLEANING AND PROTECTION

A. Protect detectable warning tiles against damage during construction period to comply with tile manufacturer's specifications.

B. During and after the detectable warning tiles installation and the concrete curing stage, it is imperative that there are no walking, leaning, or external forces placed on the tile to rock the tile, causing a void between the underside of the tile and the concrete substrate.

C. Remove protective plastic sheeting from detectable warning tiles within 24 hours of installation.

D. Clean tiles not more than five (5) days prior to date scheduled for inspection intended to establish date of Substantial Completion in each area of the project.

END OF SECTION 321726

SECTION 323219 - UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Concrete masonry unit walls to which brick veneer will be applied.

B. Related Sections: The following Sections contain requirements that relate to this Section:

"Brick Masonry Veneer" for stone to be applied to walls.
“Cast in Place Concrete” for concrete wall foundation.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Submittals: In addition to product data, submit the following:

1. Shop drawings for reinforcing detailing fabrication, bending, and placement of reinforcing bars.
2. Samples for masonry units, brick and mortar showing the full range of colors.
3. Material certificates for each different masonry product required.
4. Material test reports from a qualified independent testing agency for mortar, grout mixes, and masonry units.
5. Product literature for structural reinforcing materials.

C. Mockup: Construct sample wall panels approximately 48 inches (1200 mm) long by 48 inches (1200 mm) high by full thickness, including face and back-up wythes as well as accessories, to verify selections made under sample submittals and to demonstrate aesthetic effects of materials and execution.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has completed work similar in material, design, and extent to that indicated for this Project and with a record of success.

B. Cold-Weather Requirements: Do not build on frozen subgrade or setting beds. Remove and replace unit masonry damaged by frost or freezing conditions. Comply with the following requirements:

1. Cold-Weather Construction: Heat mixing water and sand to produce mortar and grout temperatures between 40 and 120 deg F (4 and 49 deg C). Maintain mortar and grout above freezing. Heat masonry units to 40 deg F (4 deg C) if grouting.

2. Cold-Weather Protection: Cover masonry with insulating blankets or provide enclosure and heat to maintain temperatures above 32 deg F (0 deg C) for 48 hours after construction. Install wind breaks when wind velocity exceeds 15 mi./h (25 km/h).

C. Hot-Weather Requirements: Protect unit masonry work from excessive evaporation of water from mortar and grout. Do not apply mortar to substrates with temperatures of 100 deg F (38 deg C) and above.

PART 2 – PRODUCTS

2.1 PRODUCTS

A. Colors, Textures, and Patterns: Provide masonry units and mortar for exposed work matching Architect's samples or, if none, as selected by Architect from manufacturer's full range of colors, textures, and patterns.

B. Concrete Masonry Units: ASTM C 90 and as follows:

1. Compressive Strength: 1900 psi (13.1 MPa) minimum average net-area compressive strength.
2. Weight Classification: Normal weight.
3. Provide Type I, moisture-controlled units.
4. Size: Manufactured to the actual dimensions of 3/8 inch (10 mm) less than nominal sizes indicated on Drawings:

C. Prefaced Concrete Masonry Units: Lightweight concrete units indicated below with manufacturer's standard smooth resinous tile facing, complying with ASTM C 744:

1. For Units to Which Prefaced Surfaces Are Applied: ASTM C 90, Type I, hollow, moisture-controlled units. Comply with requirements for unfaced units except as otherwise indicated.
2. Size: Manufactured to dimensions indicated for unfaced units, but with prefaced surfaces having 1/16-inch- (1.5-mm-) thick returns of facing to create 1/4-inch- (6.5-mm) wide mortar joints with modular coursing.

D. Brick Veneer:

1. Obtain same brick to be installed on building. Submit samples for approval.

E. Mortar and Grout Materials: As follows:

1. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction.
2. Masonry Cement: ASTM C 91.
3. Mortar Cement: U.B.C. Standard No. 21-14.
4. For pigmented mortars, use premixed, colored-cement or cement-lime mix of formulation required to produce color indicated. Coordinate with building contractor to match mortar color for walls with that of the building.
5. Hydrated Lime: ASTM C 207, Type S.
6. Aggregate for Mortar: ASTM C 144; except for joints less than 1/4 inch (6.5 mm), use aggregate graded with 100 percent passing the No. 16 (1.18 mm) sieve.
7. Aggregate for Grout: ASTM C 404.
8. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494, Type C, and recommended by the manufacturer for use in masonry mortar of composition indicated.
9. Water: Potable.

F. Steel Reinforcing Bars: Billet steel complying with ASTM A 615, Grade 60 (ASTM A 615M, Grade 400).

G. Deformed Reinforcing Wire: ASTM A 496, with ASTM A 153, Class B-2 zinc coating.

H. Joint Reinforcement: Provide joint reinforcement formed from galvanized carbon-steel wire, ASTM A 641 (ASTM A 641M), Class 1, for interior walls; and ASTM A 153, Class B-2, for exterior walls.

1. Description: Welded-wire units prefabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 10 feet (3 m), with prefabricated corner and tee units.

I. Ties and Anchors, General: Provide ties and anchors that comply with the following requirements, unless otherwise indicated.

1. Wire: As follows:

a. Galvanized Carbon-Steel Wire: ASTM A 82; with ASTM A 153, Class B-2 coating for exterior walls; and with ASTM A 641 (ASTM A 641M), Class 1 coating for interior walls.

2. Steel Sheet: As follows:

a. Galvanized Steel Sheet: ASTM A 366 (ASTM A 366M) (commercial quality) cold-rolled, carbon-steel sheet hot-dip galvanized after fabrication to comply with ASTM A 153, Class B-3, for sheet-metal ties and anchors in exterior walls; ASTM A 526, G 60 (ASTM A 526M, Z 180) (commercial quality), steel sheet zinc coated by hot-dip process on continuous lines prior to fabrication, for sheet-metal ties and anchors in interior walls.

J. Miscellaneous Masonry Accessories: As follows:

1. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Type 2, Class A, Grade 1; compressible up to 35 percent; of width and thickness indicated.
2. Preformed Control-Joint Gaskets: Designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated, made from styrene-butadiene rubber complying with ASTM D 2000, Designation M2AA-805.
3. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
4. Weep Holes: Provide the following:

a. Round Plastic Tubing: Medium-density polyethylene, 3/8-inch (9-mm) outside diameter by 4 inches (100 mm) long.
b. Wicking Material: Cotton sash cord, in length required to produce 2-inch (50-mm) exposure on exterior and 18 inches (450 mm) in cavity between wythes.

K Special Structural Reinforcement Materials:

1. Wire-Bond, three-wire system with adjustable tabs, Series 700, Hot-dipped galvanized after fabrication, ASTM-A 153, Class B2, N.8 GA). Manufacturer: Masonry Reinforcing Corporation of America. Or approved equivalent.

L. Masonry Cleaners: As follows:

1. Job-Mixed Detergent Solution: Solution of 1/2-cup (0.14-L) dry measure tetrasodium polyphosphate and 1/2-cup (0.14-L) dry measure laundry detergent dissolved in 1 gal. (4 L) of water.
2. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other stains from masonry surfaces; expressly approved for intended use by manufacturer of masonry units being cleaned.

M. Mortar and Grout Mixes: Do not use admixtures unless otherwise indicated. Do not use calcium chloride in mortar or grout.

1. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification, for job-mixed mortar; and ASTM C 1142 for ready-mixed mortar, of types indicated below:
   a. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.

2. Pigmented Mortar: Select and proportion pigments with other ingredients to produce color required.

   a. For portland cement-lime mortar, limit pigments to not more than 10 percent of cement content by weight.

3. Grout for Unit Masonry: Comply with ASTM C 476. Use grout of consistency to completely fill spaces intended to receive grout.

N. Source Quality Control: Contractor will employ and pay a qualified independent testing agency to perform the following tests:

1. Concrete Masonry Unit Tests: ASTM C 140, for each type of concrete masonry unit indicated.

PART 3 – EXECUTION

3.1 EXECUTION

A. Cut masonry units with motor-driven saws. Allow units cut with water-cooled saws to dry before placing, unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

B. Mix units for exposed unit masonry from several pallets or cubes as they are placed to produce uniform blend of colors and textures.

C. Wetting of Stone: Wet stone prior to laying if the initial rate of absorption exceeds 30 g/30 sq. in. (g/194 sq. cm) per minute when tested per ASTM C 67. Allow units to absorb the water so they are damp but not wet at the time of laying.

D. Construction Tolerances: As follows:

1. Variation from Plumb: For vertical lines and surfaces do not exceed 1/4 inch in 10 feet (6 mm in 3 m), nor 3/8 inch in 20 feet (10 mm in 6 m), nor 1/2 inch in 40 feet (12 mm in 12 m) or more. For vertical alignment of head joints, do not exceed plus or minus 1/4 inch in 10 feet (6 mm in 3 m) nor 1/2 inch (12 mm) maximum.
2. Variation from Level: Do not exceed 1/4 inch in 20 feet (6 mm in 6 m) nor 1/2 inch in 40 feet (12 mm in 12 m).

3. Variation of Linear Building Line: For position shown in plan, do not exceed 1/2 inch in 20 feet (12 mm in 6 m) nor 3/4 inch in 40 feet (19 mm in 12 m).
4. Variation in Cross-Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/4 inch (6 mm) nor plus 1/2 inch (12 mm).
5. Variation in Mortar-Joint Thickness: Do not vary from bed-joint thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm). Do not vary from head-joint thickness indicated by more than plus or minus 1/8 inch (3 mm).

E. Lay out walls in advance for accurate spacing of surface bond patterns and for accurate locating of openings, movement-type joints, returns, and offsets. Avoid the use of less-than-half-size units at corners, jambs, and where possible at other locations.

F. Built-in Work: As construction progresses, build-in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built-in items.

G. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.

H. Keep cavities clean of mortar droppings and other materials during construction. Strike joints facing cavities flush.

1. Use wood strips temporarily placed in cavity to collect mortar droppings. As work progresses, remove strips, clean off mortar droppings, and replace in cavity.

I. Provide continuous horizontal-joint reinforcement as indicated. Install with a minimum cover of 5/8 inch (16 mm) on exterior, 1/2 inch (13 mm) elsewhere. Lap a minimum of 6 inches (150 mm).

1. Provide continuity at corners and wall intersections by using prefabricated "L" and "T" sections.

J. Trim wicking material used in weep holes flush with outside face of wall after mortar has set.

K. Temporary Formwork and Shores: Construct formwork and shores to support reinforced masonry elements during construction.

1. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.

L. Grouting: Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.

1. Do not exceed the following pour heights for fine grout:

a. For minimum widths of grout spaces of 3/4 inch (19 mm) or for minimum grout space of hollow unit cells of 1-1/2 by 2 inches (38 by 51 mm), pour height of 12 inches (305 mm).
b. For minimum widths of grout spaces of 2 inches (51 mm), pour height of 60 inches (1524 mm).

M. Field Quality Control: The Owner will employ and pay a qualified independent testing agency to perform the following tests during construction for each 5000 sq. ft. (460 sq. m) of wall area or portion thereof:

1. Mortar Properties: ASTM C 270.
2. Mortar Composition and Properties: ASTM C 780.
3. Grout: ASTM C 1019.

N. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears prior to tooling joints.

O. Final Cleaning: After mortar is thoroughly set and cured, remove mortar particles with nonmetallic scrapers, and clean exposed masonry as follows:

1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
2. Protect adjacent surfaces from contact with cleaner.
3. Wet wall surfaces with water prior to application of cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
4. Clean stone by bucket and brush method described in BIA Technical Note No. 20 Revised, using the specified masonry cleaner.

P. Masonry Waste Disposal: Dispose of clean masonry waste, including broken masonry units, waste mortar, and excess or soil-contaminated sand, by crushing and mixing with fill material as fill is placed.

1. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.

END OF SECTION 32 32 19

SECTION 32 33 00 - SITE AMENITIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Related work is specified in the following Sections:

1. Earthwork
2. Concrete

1.02 DESCRIPTION OF WORK

A. Extent of miscellaneous site amenity work is shown on drawings in schedules and as specified herein.

B. Furnish all labor, equipment and materials necessary to complete the installation of all work indicated on the drawings, herein specified or both. Work includes but is not limited to the following items:

1. Decorative Aluminum Picket Fence
2. Flagpole
3. Fire Pit
4. Signage

1.03 QUALITY ASSURANCE

A. All specified items shall be approved by the Owner prior to installations.

B. Follow manufacturer's recommendations for installation of materials and products unless otherwise detailed on the drawings. In the event of a conflict between the Manufacturer's recommendation and the Contract Documents, notify the Owner for clarification prior to installation.

C. Do not make substitutions. If specified material or product is not obtainable, submit proof of non-availability to the Owner along with a written proposal for use of equivalent material prior to bid.

1.04 SUBMITTALS

A. Where shop drawings are required by these Specifications, submission shall be made as described in Division 1. Include dimensioned plans, elevations, and details of sections and connections. Show anchorage and accessory items. Provide all templates and applicable installation instructions.

B. Where product data is required by these Specifications, submit Manufacturer's specifications, anchor details and installations instructions as described in Division 1.

C. Where samples are required by these specifications, submission shall be made in sufficient size and quantity to adequately show the material or product and any variation in size, color or shape, as described in Division 1.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver materials and products in containers that protect them from damage and mishandling. Protect materials from deterioration during delivery, and while stored at site. Any specified material or product which has been damaged to any extent during shipping shall be returned to the Manufacturer for replacement. After shipment and acceptance by the Contractor, any material or product damaged during storage or handling shall be removed from the site and replaced at the expense of the Contractor.

1.06 WARRANTIES

A. Warranty all materials and products in accordance with Division 1 Specifications.

B. At the time of Final Inspection, submit to the Owner all certificates of Manufacturer's Warranty or Guarantee and any stipulation thereof.

PART 2 PRODUCTS

2.01 DECORATIVE ALUMINUM PICKET FENCE

A. Install manufactured metal fences, gates, ball caps and posts in locations shown on drawings. Fence shall be “Estate Style K” as manufactured by Monumental Iron Works, Baltimore, Maryland. Height shall be 6’-0” or 72”.

B. Two gates shall be provided in the fence enclosing he rear courtyard, for maintenance access.

B. Concrete shall be as specified in Section 02520-Concrete.

C. Or approved equivalent. Submit samples and product literature for approval prior to ordering.

2.02 FLAG POLE

A. Contractor shall furnish and install one (1) flag pole, model #ECXV25, 27’-0” height

B. Manufactured by:

Eder Flag Manufacturing Company
1000 West Rawson Avenue
Oak Creek, Wisconsin 53154
1 (800) 558-6044

C. Features: 3” aluminum pole, .125 wall thickness, with internal halyard. Finish to be clear anodized. Flash collar to be included and finish to be clear anodized. Gold ball to be included with gold anodized finish. Package should include swivel snaps, retaining ring, counter weight and gold ball.

D. Submit manufacturer’s product literature for approval prior to placing order or installation.

2.03 FIRE PIT

A. Fabricate one (1) brick veneer fire pit with natural gas fire element, in the rear courtyard.

A. Install one (1) Hearth Product Controls fire pit insert, 121” length. Ensure a registered plumber installs pipe, connections and gas line from building meter. Install main shut-off valve near building and secondary shut-off valves at each fire pit. Coordinate gas line and valve locations with owner and other trades.

B. Fabricate brick veneer walls, concrete cap, metal vent grate and mounting brackets for fire pit insert as indicated on the drawings. Brick shall match building. Submit samples to owner for review prior to installation.

C. Submit manufacturer's product literature for owner's confirmation/approval prior to ordering and placing the order. Prepare and submit a shop drawing for owners review.

2.04 SIGNAGE

A. Signage shall be located throughout the project and shall include:
   a. Two (2) retaining wall mounted project identification signs, to be installed on the sign wall along Penfort Street
   b. Four (4) handicap accessible parking signs and (2) van accessible signs
   c. One (1) "Not an Exit" sign for between Building 1 and 4
   d. One (1) "Loading Zone" sign

B. Install as per details in the locations indicated.

D. Provide shop drawings for each installation, for review and approval, prior to installation.

2.05 MAINTENANCE

A. Begin maintenance immediately after installation.

B. Maintain materials and products until final acceptance and completion of all punch list items as verified by the Owner's letter of final acceptance.

C. Maintain materials and products by cleaning, repairing, painting or replacing appurtenances as necessary all in accordance with the Manufacturer's recommendations. Use Manufacturer's services and products if available. All maintenance shall be accomplished in a manner that will restore materials and products to their original condition.

2.06 CLEANUP AND PROTECTION

A. During miscellaneous site amenity work, keep all areas clean and in an orderly condition.

B. Protect miscellaneous site amenity work and materials from damage due to other operations, operations by other contractors and trades and trespassers. Maintain protection during installation and maintenance periods.

2.07 INSPECTION AND ACCEPTANCE

A. When miscellaneous site amenity work is completed, including maintenance, the Owner will, upon request, make an inspection to determine acceptability.

B. Where inspected miscellaneous site amenity work does not comply with requirements, replace rejected work and continue specified maintenance until re-inspected by the Owner and found to be acceptable. Remove rejected materials and products promptly from project site.

END OF SECTION 32 33 00

SECTION 32 84 00 – IRRIGATION SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. General Description Includes:
1. Complete underground irrigation system.
2. Pipe and fittings, valves, sprinkler heads, and accessories.
3. Automatic two-wire control system.
4. Excavation and backfilling for installation of underground system.
5. All necessary permits, licenses and fees.

1.02 SYSTEM DESCRIPTION

A. Layout design:
1. Full and complete coverage is a requirement. Contractor shall, at no additional costs to the Owner, modify layout, make necessary adjustments, as needed to obtain a full coverage areas without overthrow on roadways, pavements, structures, furniture, fountains or buildings and to protect trees and shrubs from close high spray velocity.
2. Provide irrigation layout with separate plant type zones:
   a. Plant beds containing Groundcover, Perennials, and Shrubs
   b. Lawn
3. Provide flow velocities that do not exceed 5.0 ft. per second.
4. Provide irrigation of lawn areas with no overspray into planting beds or pavements, unless so designed on the drawings.
5. Provide independent irrigation of individual bed zones or planters.

B. Only similar types of heads with matched precipitation rates may run on same zone.

C. Piping Design: Do not mix different heads for each line. Provide main size as needed for proper flow, but not less than specified on plan.

D. Provide electric solenoid controlled underground irrigation system manufactured especially for control of automatic circuit valves of underground irrigation system. Provide unit of capacity to suit number of circuits indicated.
1. Source Power: 120 volts
2. Low Voltage Controls: 24 volts AC.

E. Provide controller to control all zones.

F. The extent of the irrigation system is shown on the Drawings.

1.03 SUBMITTALS - REVIEW

A. Product Data: Submit manufacturer's technical data and installation instructions for all components and equipment used.

B. Shop Drawings:
1. Indicate piping layout to water source.
2. Include piping layout and details illustrating location and types of sprinkler heads, valves, control system and wiring diagram showing routes, wire sizes, wiring details and source of current and connections, and schedule of fittings.
3. Indicate location of sleeves under pavements and conflicts with existing utilities.

C. Samples
1. Submit the following material samples:

a. Piping and fittings.
b. Wire connectors and sealer.
c. Control wire.

2. Submit the following equipment samples:
   a. Sprinkler heads, one of each type, complete with housing.
   b. Valve boxes.
   c. Controller.

3. Approved equipment samples will be returned to the Contractor and may be used in the work before final approval.

1.04 SUBMITTALS - CLOSE-OUT

A. Comply with the requirements of the General Conditions.

B. Record Drawings:
1. Prepare a map diagram showing location of all valves, lateral lines, and route of the control wires. Identify all valves as to size, station, number and type of irrigation. "As-built" drawings must be approved before charts are prepared.
2. Provide one chart per controller showing the area covered by each satellite controller. The chart shall be a reduced drawing of the actual "as-built" system. If controller sequence is not legible when the drawing is reduced to door size, the drawing shall be enlarged to a size that is readable and placed folded, in a sealed plastic container, inside the controller door. A second full-sized copy of each chart is to be given to the Landscape Architect.
3. The chart shall be a photographically reproduced print with a different color used to show coverage for each station. When completed and approved, the chart shall be hermetically sealed between two pieces of clear plastic. Charts must be completed and approved prior to final inspection of the irrigation system.
4. At the time of the irrigation mainline test, provide a preliminary set of "Record" drawings to the Owner.

C. Operation and Maintenance Data:
1. Provide schedule indicating length of time each valve is required to be run to provide a determined amount of water.
2. Include complete parts list with manufacturer's designations for each component.

D. Loose Equipment to Furnish: Loose irrigation equipment, operating keys and spare parts will be furnished by the Irrigation Contractor in quantities below:
1. Two (2) quick coupler keys and matching swivel hose ells for ¾" garden hose.
2. Two (2) valve keys for gate valves.
3. Two (2) keys for each controller.
4. Two (2) of each type of sprinkler used on project, complete with housings.

1.05 QUALITY ASSURANCE

A. Installer's Qualifications: Single firm specializing in irrigation work with a minimum of five years of experience properly installing irrigation systems of comparable size. Crew leader is to hold a certification of competence in irrigation design or installation.
1. Provide references of your last five consecutive systems, and five systems of comparable size with bid proposal.

B. Multiple units: when two or more units of the same type or class of materials or equipment are required, these units are products of one manufacturer.

C. Materials, equipment, and methods of installation shall comply with the following codes and standards:

1. State of Pennsylvania Building Codes.
2. American Society for Testing and Materials (ASTM).
3. National Sanitation Foundation (NSF).

D. Nameplates: Nameplate bearing manufacturer's name or identification trademark securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.

E. Requirements of Regulatory Agencies:
1. All work and materials shall be in full accordance with the latest rules and regulations of safety orders of Division of Industrial Safety; the Uniform Building Code and other applicable laws or regulations, including any local Plumbing Codes.
2. Should the Contract documents be at variance with the aforementioned rules and regulations, notify the Owner for instructions before proceeding with work affected.

F. Testing:
1. Preliminary review of completed main line and wire installation will be made prior to backfilling of trenches and hydrostatic testing.
2. Final review and testing shall be made in conjunction with the final review of lawn, shrub and tree planting. The irrigation system must be operational for 14 days prior to this final inspection. Any failures are to be corrected and the testing cycle is to be repeated.
3. Contractor is to notify Landscape Architect 3 days prior to testing.

G. Permits and Inspections:
1. Any permits for the installation or construction of any work included under this contract, which are required by any of the legally constituted authorities having jurisdiction, shall be obtained and paid for by the contractor, each at the proper time.
2. The Contractor shall also arrange for and pay all costs in connection with any inspection and examination required by these authorities.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver irrigation system components in manufacturer's original, undamaged and unopened containers, with labels intact and legible.

B. Deliver plastic pipe in bundles, packaged to provide adequate protection of pipe ends.

C. Store and handle materials to prevent damage and deterioration.

D. Provide secure, locked storage for valves, sprinkler heads and similar components that cannot be immediately replaced to prevent installation delays.

E. Contractor is responsible for materials through final acceptance.

1.07 PROJECT CONDITIONS

A. Protect existing trees, plants, and lawns and other features designated to remain as part of the final landscape.

B. The Contractor shall carefully coordinate with the landscape work and other site developments, including all new and existing utilities.

C. The Contractor shall verify the correctness of all finish grades within the work area to ensure the proper soil coverage of the irrigation pipes.

D. Irrigation system layout is diagrammatic. Exact location of piping, sprinkler heads, valves, and other components shall be established by Contractor in the field at time of installation.

E. Where possible sprinkler head layout should match drawings as closely as possible; field stake line and head locations for coordination with landscape contractor and approval by Landscape

Architect prior to installation. Drawings are diagrammatic to the extent that swing joints, offsets and all fittings are not shown. Lines are to be common trenched wherever possible.

F. Space sprinkler components as indicated. Do not exceed sprinkler spacing shown on Drawings.

G. Locate existing utilities in areas of work. If utilities are to remain, provide adequate means of protection during the system installation. Repair utilities damaged during the work to the satisfaction of the Utility Owner and at the Contractor's expense. Notify local Utilities Protection Service 48 hours before start of construction.

H. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, notify the Owner immediately for direction as to procedure. Cooperate with the Owner and Utility companies in keeping active services and facilities in operation.

I. Minor adjustments in system layout will be permitted to clear existing field obstruction. Final system layout shall be acceptable to the Landscape Architect.

1.08 WARRANTY

A. Warranties are subject to the General Conditions and Supplementary Agreements.

B. Irrigation Contractor is responsible to insure complete coverage as specified herein of the areas to be irrigated. During the warranty period the Irrigation Contractor shall make any adjustments as necessary to maintain proper coverage.

C. The Contractor shall guarantee all parts and labor for a period of one year from the date of final inspection. If within that period settlement occurs, and adjustments in pipes, valves and sprinkler heads, lawn areas or paving are necessary to bring the system, grade or paving to the proper level of the permanent grades, the Contractor, as part of the work under his Contract, shall make all adjustments without extra cost to the Owner, including the restoration of all damaged planting, paving or other improvements of any kind.

1.09 OPERATION & MAINTENANCE — IRRIGATION SYSTEM

A. It is the Landscape Contractor's responsibility to determine water application rates and controller cycling. The Irrigation Contractor will coordinate system installation with planting soil placement and planting activities. The Irrigation Contractor will also instruct the Landscape Contractor on the operation and programming of the controller and will assist the Landscape Contractor as necessary in such operations throughout the one-year maintenance period. Any adjustments, repairs, etc., other than programming, are the total responsibility of the Irrigation Contractor.

B. As part of this contract, the Irrigation Contractor shall winterize the system the first year, and provide written instructions to the Owner for future service and maintenance. The Irrigation Contractor shall return to the site during the subsequent spring season and demonstrate to the Owner the proper procedures for the system start-up, operation and maintenance.

PART 2 - PRODUCTS

2.01 UNAUTHORIZED MATERIALS

A. Materials and products required for work of this section shall not contain asbestos, polychlorinated biphenyl (PCB) or other hazardous materials identified by the Owner.

2.02 IRRIGATION SYSTEM MANUFACTURERS

A. All irrigation system components shall be supplied by regionally authorized distributors to provide single source responsibility for warranty service and operations to conform to specifications in all aspects.

2.03 MATERIALS

A. All materials to be incorporated in this system shall be new and without flaws or defects and of quality and performance as specified and meeting the requirements of this system.

B. Plastic Pipe
1. All piping shall be from virgin parent material. The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign materials, blisters, deleterious wrinkles and dents. All pipe shall be National Sanitation Foundation (NSF) approved.
2. For all irrigation piping, use polyvinyl chloride (PVC) 1120 SDR21 with a minimum class rating of 200, sized to maintain a maximum flow velocity of less than 5 ft. per second (FPS).
3. Outside diameter of pipe shall be the same as iron pipe.
4. Pipe shall be marked at intervals (not to exceed 5') with the following information: Manufacturer's name or trademark, nominal pipe size, schedule, PVC type and grade (i.e. PVC 1120), SDR rating class, working pressure at 73 degrees F. and NSF approval.
5. Caution should be utilized in handling Type I pipe due to the possibility of cracking or splitting when dropped or handled carelessly.
6. When connection is plastic to metal, male adapters shall be used. The male adapter shall be hand tightened, plus one turn with a strap wrench.
7. Comply with pipe sizes indicated on drawings. No substitution of smaller pipe will be permitted. Larger sizes may be used subject to acceptance of the Landscape Architect. Remove damaged and defective pipe from site.
8. All PVC pipe to be furnished in 20' lengths.
9. Acceptable Manufacturer:
   a. Silverline Plastics or approved equivalent

C. Piping for Sleeving
1. For sleeves less than 6" in size, use high impact type, polyvinyl chloride (PVC) 1120, minimum Schedule 40.
2. Sleeves 6" and above in size shall be Polyvinyl Chloride (PVC) 1120 Class 200.
3. Irrigation Contractor shall be responsible for the coordination of sleeves for all piping passing through concrete curbing, under paved areas, concrete or masonry walls and floors while the same are under construction.
4. Acceptable Manufacturer:
   a. Silverline Plastics or approved equivalent

D. PVC Fittings
1. Schedule 40 or 80, polyvinyl chloride (PVC), Type 1 injection molded fittings suitable for solvent weld or threaded connections. Fittings made of other materials are not permitted.
2. Threaded PVC nipples shall be Schedule 80. Use high quality grade of Teflon tape for threaded fittings.
   a. Saddle fittings are not permitted.
   b. Use high quality grade of Teflon tape for sprinkler head and electric remote control valve connections.
3. Acceptable Manufacturer:
   a. Spears Manufacturing or approved equivalent

E. Isolation Valves
1. Gate valves under 3" shall be 200 PSI rated W.O.G. 200 domestically manufactured with bronze bodies. Valves shall be equipped with tee handles.
2. The valve shall have a 100% urethane coated wedge insuring a bubble-tight seal up to 200 PSI. The valve shall be fusion-bonded epoxy coated with PVC push-on, threaded or mechanical connections and a two-inch square nut for vertical valve stem key.
3. Acceptable Manufacturer:
   a. Watts Regulator or approved equivalent

F. Quick Coupling Valves

1. Valve shall be of two-piece construction with a 1” female top thread with locking rubber cover.
2. Furnish one valve key fitted with 3/4-inch swivel hose ells.
3. All quick coupling valve keys and hose swivels shall be of the same manufacturer as the quick coupler.
4. Acceptable Product:
   a. Rain Bird model 5RC or approved equivalent

G. Valve Boxes

1. Tapered rib reinforcement enclosure of rigid tensile strength plastic material components chemically inert and unaffected by moisture, ultra violet light, corrosion and temperature changes. Lid and base shall withstand normal loads exerted by turf equipment without collapsing. Box and lid to be black.
2. For remote control valves use rectangular standard turf box, 19” x 14”.
3. For Isolation valves and quick coupler valves use 10” circular turf box.
4. Acceptable Manufacturer:
   a. Rain Bird VB series or approved equivalent

A. Spray Heads

1. Full or part circle pop-up fixed spray sprinkler.
2. The sprinkler body, stem, nozzle and screen shall be constructed of heavy-duty, ultra-violet resistant plastic. It shall have a heavy-duty stainless steel retract spring for positive pop-down and a ratcheting system for easy alignment of the pattern. The sprinkler shall have a soft elastic pressure-activated co-molded wiper seal for cleaning debris from the pop-up stem as it retracts into the case to prevent the sprinkler from sticking up to minimize “flow-by.” The sprinkler shall have a matched precipitation rate (MPR) plastic nozzle with an adjusting screw capable of regulating the radius and flow. The sprinkler shall be capable of housing under the nozzle; protective, non-clogging filter screens or pressure compensating screens. The screen shall be used in conjunction with the regulating screw for regulating.
3. The sprinkler shall have a flush plug reinstalled. The plug shall prevent debris from clogging the sprinkler during installation and allow for system to be flushed before nozzling. The plug shall be bright orange in color and constructed of polypropylene material.
4. The 4”, 6” or 12” high pop-up spray sprinklers shall also include an integral pressure-regulating device (PRS). The sprinklers shall also include an integral check valve such as a Seal-A-Matic (SAM) and an integral flow-shield and pressure regulator.These units shall be identifiable from the top with markings such as “SAM-PRS” on top.
5. The check valve shall prevent low-head drainage of up to 8 feet of head. The pressure regulating device shall prevent high pressure fogging of the nozzle stream by regulating the nozzle pressure to 30 PSI for inlet pressure from 35 to 70 PSI
6. Pop-up heights: 4 inches, 6 inches and 12 inches (see drawings).
7. Nozzles for sprinkler heads shall be of the same manufacturer as the sprayhead.
8. Acceptable Product:
   (a) Rain Bird model 1800SAMPRS series or approved equivalent

B. Rotator Nozzles

1. The rotary nozzle shall have an adjustable arc of between 90 and 210 degrees and shall be capable of covering a 10-30’ radius at 30 PSI.
2. The rotary nozzle shall have multiple arced streams and have a matched precipitation rate of 0.60 in/hr.
3. The rotary nozzle shall be constructed of UV-resistant plastic. The radius adjustment screw shall be of stainless steel and shall include a removable mesh screen to protect the nozzle against clogging.
4. Acceptable Products:
   a. Rain Bird R-VAN or approved equivalent

C. Rotors

1. The full or part circle rotor sprinkler shall be a single stream, water lubricated, gear drive.
2. The sprinkler shall have adjustable arc coverage form 40 to 360 degrees in one unit.
3. The sprinkler shall have a pressure-activated multi-function wiper seal that positively seals against the nozzle flange to keep debris out of the rotor and to clean debris from the pop-up stem as it retracts. The wiper seal shall prevent sprinkler from sticking up, and be capable of sealing the sprinkler cap to sprinkler body under normal operating pressures.
4. The sprinkler shall be fully adjustable from the top using only a flat-blade screwdriver.
5. The sprinkler shall have a screen attached to the drive housing to filter inlet water, protect the drive from clogging and simplify its removal for cleaning and flushing of the system. It shall have a ¾" (FNTP) bottom inlet.
6. The sprinkler shall have a stainless steeladjusting screw capable of reducing the radius up to 25%.
7. The sprinkler shall have a strong stainless steel retract spring for positive pop down. It shall have a check valve to check 7 feet of elevation change (if specified on the Drawing).
8. When indicated on the Drawings, the sprinklers shall have an integral check valve (SAM device) capable of holding back 8' of elevation.
9. Acceptable Product:
   a. Rain Bird model 5004 or approved equal.

D. Drip Tubing

1. Drip tubing shall be continuously self-flushing and pressure compensating. It shall consist of nominal sized one-half inch low density, linear polyethylene tubing, housing internal pressure compensating, continuously self-flushing, integral drip emitters.
2. The tubing shall be brown in color and conform to an outside diameter (O.D.) of 0.67 inches, and an inside diameter (I.D.) of 0.57 inches. The emitters shall have the ability to independently regulate discharge rates, with an output pressure of seven (7) to seventy (70) PSI, at a constant flow.
3. The emitter discharge rate shall be either 0.61 gallons per hour (GPH), utilizing a combination turbulent flow/reduced pressure compensation cell mechanism and a diaphragm to maintain uniform discharge rates. The emitters shall continuously clean themselves while in operation. The dripperline shall have 18" spacing between emitters as noted on drawing.
4. Acceptable Product:
   a. Rain Bird XFD-06-18 inline drip tubing or approved equivalent

E. Automatic Controller, 2-Wire

1. The controller shall be of a hybrid type that combines electro-mechanical and microelectronic circuitry capable of fully automatic or manual operation. The controller shall be housed in a wall-mountable, weather-resistant plastic cabinet with a key-locking cabinet door suitable for either indoor or outdoor installation.
2. The controller shall have a base station capacity of 50 stations with two additional expansion slots capable of receiving modules to create a controller capacity of up to 200 stations. All stations shall have the capability of independently obeying or ignoring any weather sensor as well as using or not using the master valves. Station timing shall be from 0 minutes to 12 hours.
3. The controller shall have a Seasonal Adjustment by program which adjusts the station run time from 0 to 300% in 1% increments. The controller shall also have a Monthly Seasonal Adjustment of 0 to 300% by month. Station timing with Seasonal Adjustment shall be from 1 second to 16 hours.
4. The controller shall have 4 separate and independent programs which can have different start times, start day cycles, and station run times. Each program shall have up to 8 start times per day for a total of 32 possible start times per day. The 4 programs shall be allowed to overlap operation based on user defined settings which control the number of simultaneous stations per program and total for the controller. The controller shall allow up to 8 valves to operate simultaneously per program and total for the controller including the master valves.

5. The controller shall have a 365-day calendar with Permanent Day Off feature that allows a day(s) of the week to be turned off on any user selected program day cycle.
6. The controller shall also have a Calendar Day Off feature allowing the user to select up to 5 dates up to 365-days in the future when the controller shall not start programs.
7. The controller shall incorporate a Rain Delay feature allowing the user to set the number of days the controller should remain off before automatically returning to the auto mode.
8. The controller shall have Cycle+Soak water management software which is capable of operating each station for a maximum cycle time and a minimum soak time to reduce water run-off. The maximum cycle time shall not extended by Seasonal Adjustment.
9. The controller shall offer Water Windows for each program. This function sets the allowed start and stop time where watering is allowed. If the watering cannot be completed by the time the Water Window closes, the stations with remaining run time are paused and watering automatically resumes when the Water Window opens the next time.
10. The controller shall include an integrated Flow Smart Module with flow sensing functionality. The Flow Smart Module shall accept sensor decoder input from 1 - 5 flow sensors with no flow scaling device required. A FloWatch Learn Flow Utility which learns the normal flow rate of each station shall be included. Each time a station runs FloWatch compares the current real-time flow rate to the learned rate and takes user-defined actions if high flow, low flow, or no flow is detected. FloWatch shall automatically determine the location of the flow problem and isolate the problem by turning off the affected station(s) or master valve(s).
11. Acceptable Product:
    (a) Rain Bird ESP-LXD series or approved equivalent

F. Line Decoders
1. The factory pre-coded decoders shall be fully waterproof and have a working range shall be 0 degrees C to 50 degrees C at up to 100% humidity.
2. Decoders shall be capable of operating from one to six solenoids depending on the model specified on the Drawings
3. Four and six address decoders shall have integral surge protection.
4. Acceptable Product:
   (a) Rain Bird LD series or compatible with approved controller

G. Control Wire
1. Hot wire: Single cable with two strands of solid copper wire type, with PVC jacket. UF 600-volt AWG #14 minimum size, approved for direct burial. For runs over 2,000 L.F. use AWG #12. Contractor to verify that wire sizes are within recommended wire run lengths for proper solenoid operation.

H. Rain Shutoff
1. One device shall be provided for each controller. Install per manufacturer's latest printed instructions.
2. Verify with Landscape Architect as to final location of rain shutoff.
3. Acceptable Product:
   a. Rain Bird model RSD or approved equivalent

I. Remote Control Valves (Sprinklers)
1. The electric remote control valve shall be a normally closed 24 VAC 50/60 Hz (cycles/sec) solenoid actuated globe/angle pattern design. The valve pressure rating shall not be less than 150 PSI.
2. The valve body and bonnet shall be constructed of high-impact, water-resistant PVC for the body and glass-filled nylon for the bonnet with stainless steel screws.
3. The valve shall have manual open/close control (internal bleed) for manual opening and closing of valve without electrically energizing the solenoid. The valve's internal bleed shall prevent flooding of the valve box.
4. The valve shall house a fully-encapsulated, one-piece solenoid. The solenoid shall have a captured plunger with a removable retainer for easy servicing, and a leverage handle for easy

turning. This 24 VAC 50/60 Hz solenoid shall open with 19.6 VAC minimum at 150 PSI. At 24 VAC, average inrush current shall not exceed 0.41 amps. Average holding current shall not exceed 0.28 amps.

5. The valve shall have a flow control stem for accurate manual regulation and/or shut off of outlet flow. The valve must open or close in less than 1 minute at 150PSI and less than 30 seconds at 20 PSI.
6. The valve construction shall provide for all internal parts to be removable from the top of the valve without disturbing the valve installation. The body shall have a removable O-ringed plug for installation in either globe or angle configuration.
7. Acceptable Product:
   a. Rain Bird model PGA or approved equivalent

J. Remote Control Valves (Drip)

1. The remote control valve shall be normally closed 24 VAC 50/60-cycle solenoid actuated globe pattern. The pressure rating shall not be less than 150 PSI.
2. The valve body and bonnet shall be constructed of UV-resistant plastic and have stainless steel screws; diaphragm shall be of nylon reinforced nitrile rubber.
3. The valve shall have both internal and external manual open/close control (internal and external bleed) to manually open and close the valve without electrically energizing the solenoid. The valve's internal bleed shall prevent flooding of the valve box.
4. The valve shall house a fully encapsulated, one-piece solenoid. The solenoid shall have a captured plunger with a removable retainer for easy servicing, and a leverage handle for easy turning. This 24 VAC 50/60 Hz solenoid shall open with 19.6-volt minimum at 150 PSI. At 24 VAC average inrush current shall not exceed .23 amps.
5. The valve construction shall be such as to provide for all internal parts to be removable from the top of the valve without disturbing the valve installation.
6. The complete valve control kit shall consist of the electric valve, a 200-mesh stainless steel filter screen, and a 30-psi pressure regulator.
7. See Drawings for size of valves.
8. Acceptable Product:
   a. Rain Bird model XCZPGA-100-PRF or approved equivalent

K. Accessory materials

1. Drainage fill at valve boxes:
   a. Provide 1" washed pea gravel in each valve box.
2. Suitable excavated materials removed to accommodate the irrigation system work shall be used as fill materials provided it conforms to the requirements of fill as noted above.

L. PVC Solvent Cement:

1. Provide professional grade cement, Whitlam #PR32 or approved equivalent for PVC pipe and fittings.

M. PVC Primer/Cleaner

1. Provide professional grade primer/cleaner, Whitlam #PP32 or approved equivalent (purple) primer.

PART 3 - EXECUTION

3.01 GENERAL

A. Lay out work as accurately as possible to Drawings. Drawings are diagrammatic to the extent that swing joints, offsets, and fittings are not shown.

B. The Irrigation Contractor shall carefully schedule his work with the Landscape Contractor and all other site developments.

C. Sleeves are required wherever piping or electrical wires are placed under paved surfaces. (Installed as part of other sections and Contract). Irrigation Contractor is responsible for coordination of all sleeves.

D. Full and completed coverage is required. Contractor shall make any necessary minor adjustments to layout as required to achieve full coverage of irrigated areas at no additional cost to the Owner.

E. Where piping is shown on drawings to be under paved areas but running parallel and adjacent to planted areas, the intent is to install piping in planted areas. Do not install directly over another line in the same trench.

F. It shall be the Contractor's responsibility to establish the location of all sprinkler heads in order to assure proper coverage of all areas. In no case shall spacing of sprinkler heads exceed distances shown on the drawings and/or those specified. Pipe sizes shall conform to those shown on drawings. No substitution of smaller pipe sizes will be permitted, but substitutions of larger sixes may be approved. All pipe damaged or rejected because of defects shall be removed from the site at the time of said rejection.

G. Install irrigation system after completion of site grading, the irrigation system shall be installed and completely operational three days prior to the installation of any planting operations.

3.02 POINT OF CONNECTION

A. Provide irrigation system complete from point of connection. See Drawings for Point of Connection (POC).

3.03 EXCAVATING

A. All piping is to be trenched.

B. Excavate to depths required to provide six inchesof Granular Fill bedding material under paved surfaces.

C. Should utilities not shown on the plans be found during excavations, the Contractor shall promptly notify the Owner for instructions as to further actions required. Failure to do so will make Contractor liable for any and all damage thereto arising from his operations subsequent to discovery of such utilities. Indicate such utility crossings on the record drawings promptly.

D. Install main line irrigation lines with a minimum cover of eighteen inches and a maximum cover of twenty-four inches based on finished grades.

E. Install lateral irrigation lines with a minimum cover of twelve inches and a maximum cover of twenty-four inches based on finished grades.

F. Perform all excavations as required for installation of work included under this Section, including shoring of earth banks, if necessary. Restore all surfaces, existing underground installations, etc., damaged or cut as a result of the excavations, to their original condition.

G. Trenches shall be open, vertical sided construction wide enough to provide free working space around work installed and to provide adequate space for backfilling and compacting.

H. When two pipes are to be placed in the same trench, a six-inch space is to be maintained between the pipes. The Contractor shall not install two pipes with one directly above the other.

I. The Contractor shall cut trenches for pipe to required grade lines and compact trench bottom to prove accurate grade and uniform bearing for the full length of the line.

J. The Contractor shall be held responsible for damages caused by these operations and shall immediately repair or replace damaged parts.

3.04 PIPE LINE ASSEMBLY

A. General

1. Install pipes and fittings in accordance with manufacturer's latest printed instructions.
2. Clean all pipes and fittings of dirt, scales and moistures before assembly.
3. All pipe, fittings and valves, etc., shall be carefully placed in the trenches. Interior of pipes shall be kept free from dirt and debris and when laying is not in progress, open ends of pipe shall be closed by approved means.
4. All lateral connections to the main line as well as all other connections shall be made to the side of the main line pipe. No connections to the top of the line shall be allowed.

B. Solvent-Welded Joints for PVC Pipe
1. Use solvents and methods approved by solvent and pipe manufacturers.
2. Cure joint a minimum of one hour before applying any external stress on the piping and at least twenty four hours before placing the joint under water pressure, unless otherwise specified by the manufacturer. Cut all pipe with square ends and remove burrs, ridges and dirt. Check dry fit pipe and fitting. Clean pipe and fitting with purple primer and apply thin coat of cement to fitting with a liberal coat to pipe. Quickly push pipe fully into fitting using a ¼ turning motion. Hold pipe and fitting together a minimum of 30 seconds, wipe off excess with cloth.

C. Threaded Joints for PVC Pipe
1. Use Teflon tape on all threaded PVC fittings.
2. Use strap-style friction wrench only. Do not use metal-jawed wrench.

D. Laying of Pipe
1. Pipes shall be bedded in at least in at least two inches of finely divided material with no rocks or clods over one inch diameter to provide a uniform bearing.
2. Pipe shall be snaked from side to side of trench bottom to allow for expansion and contraction. One additional foot per 100 feet of pipe is the minimum allowance for snaking.
3. Do not lay PVC pipe when there is water in the trench.
4. Plastic pipe shall be cut with PVC pipe cutters or hacksaw, or in a manner so as to ensure that a square cut. Burrs at end cuts shall be removed prior to installation so that a smooth unobstructed flow will be obtained.
5. All plastic-to-plastic joints will be solvent-weld joints or slip seal joints. All plastic pipe and fittings shall be installed as outlined and instructed by the pipe manufacturer and it shall be the Contractor's responsibility to make arrangements with the pipe manufacturer for any field assistance that may be necessary. The Contractor shall assume full responsibility for the correct installation.

3.05 PVC SLEEVES AND ELECTRICAL CONDUIT

A. Provide all sleeves indicated and as otherwise required for the successful completion of the irrigation system. Coordinate sleeving efforts with General Contractor and the Owner.

B. All PVC sleeves shall be a minimum of twice the diameter of pipe to be sleeved.

C. All PVC control wire conduit shall be of sufficient size to hold the required quantity of control and common wires. Electrical wires are not to be placed in the same trench with water pipes.

3.06 ISOLATION VALVES

A. Shall be located in the following locations:
1. After backflow preventer and prior to main supply loop.
2. Between main line and each quick coupler valve.
3. As located on irrigation system drawings within lawn areas.

B. Install each isolation valve in an individual valve box with a six-inch (deep) layer of washed gravel below the bottom of the valve.

C. Seal threaded connections with Teflon tape.

3.07 IRRIGATION CONTROL VALVES

A. Coordinate location of all valve boxes with Landscape Architect. Do not proceed in uncertainty.

B. All irrigation control valves shall be installed with ductile iron service tees.

C. Install line size bronze gate valve on pressure side of each control valve. Locate in valve box with control valve.

D. Install each electric control valve in an individual valve box with a six-inch (deep) layer of washed gravel below the bottom of the valve.

E. Seal threaded connections with Teflon tape.

F. Valves shall be installed as shown in details and in accordance with manufacturer's instructions and specifications.

3.08 QUICK COUPLING VALVES

A. Shall be set a minimum of twelve inches from walks, curbs, or paved areas where applicable or as otherwise noted. Quick coupling valves shall be housed in standard size valve boxes.

B. All quick coupler valves shall be installed on to ductile iron service tee.

C. Install one inch bronze gate valve on pressure side of each quick coupler valve. Locate in valve box with quick coupler valve.

D. Valves shall be installed on a three-elbow PVC Schedule 80 swing joint assembly.

E. Provide six-inch (deep) layer of washed gravel below the bottom of the valve. Top of quick coupler valves shall be as close to the top of the valve box as possible. Top of gravel layer shall be three inches below the top of the valve.

F. Quick coupling valves shall be set perpendicular to finished grade unless otherwise designated on the plans.

G. Quick coupler locations are to be staked in the field by installer for approval by Landscape Architect prior to installation.

3.09 VALVE BOXES

A. Valve boxes shall be set flush with grade in lawn areas and one half inch above finish grade in ground cover and shrub bed areas.

B. Install valve access boxes on a suitable base of gravel to provide a level foundation at proper grade and to provide drainage of the valve box.

3.010 SPRINKLERS

A. All sprinkler heads shall be pop-up type heads. Permanent shrub risers are not permitted.

B. All sprinkler heads within a zone shall have matched precipitation rates.

C. Install plumb to within 1/16", unless otherwise noted (see detail for heads on sloped areas on detail sheet). Top of collar (not nozzle) should be flush with finish grade.

D. Place part-circle pop-up sprinkler heads at least two inches and no more than six inches from edge of adjacent walks, curbs and mowing bands, or paved areas at time of installation.

E. Install pop-up sprinkler heads, and accessories in accordance with manufacturer's latest printed instructions, except as otherwise noted.

F. All sprinkler nozzles shall be adjusted for the proper radius and direction of spray pattern. Make adjustments where possible to prevent overspraying onto walks, pavement or buildings.

G. Tighten nozzles on spray type sprinklers after installation. Adjust sprinkler adjusting screw as required for proper radius.

H. Install pop-up sprayheads with approved flexible thick wall polyethylene swing pipe with spiral barb fittings. Do not install to side inlet of sprinkler head.

I. Install pop-up mid-range turf rotors with approved flexible thick wall polyethylene swing pipe with spiral barb fittings.

J. Install pop-up long-range turf rotors with PVC unitized swing joints with one-piece riser assembly. Swing joints to be factory assembled with 360 degree O-ring seals as manufactured by Lasco. All connections to be threaded, no glued connections shall be allowed on the swing joints.

K. Polyethylene swing joints are not to be used to extend head more than eighteen inches (18") from lateral.

L. Heads to be installed at the top of a slope shall be tilted toward the toe of the slope. They shall also be installed slightly down from the top edge of the slope to decrease wind drift.

M. Mid-slope sprinkler heads shall be installed at an angle halfway between vertical and perpendicular to the slope. For example, a 2:1 or 50% slope has an angle of 26 degrees, so tilt the heads 13 degrees into the slope from the perpendicular.

N. Heads installed at the toe of the slope shall be tilted slightly away from the slope to avoid driving water into the slope directly in front of the sprinkler.

O. Do not mix different types of heads within a zone.

3.011 DRIP TUBING

A. Tubing is designed for use in surface and sub-surface applications utilizing a grid design, the result being a complete wetted area within the grid. It can also be installed as single or "snaked" lines where grids are not justified. The most uniform way to install tubing is sub-surface at a uniform depth as specified.

B. Tubing is available in dripper flow rates of 0.61 gallons per hour with drippers spaced at 12" intervals. The drippers are designed to regulate flow at the specified output from 7 to 70 PSI with maximum recommended pressure of 45 PSI when using unclamped insert fittings. The choice of dripper spacing and lateral spacing is dependent on the soil type and plants being used. See drawing for details.

C. Dripperline shall be staked down using 6" galvanized sod staples. Staples shall be spaced no further than 24" on center, but the contractor will place staples as closely as necessary to ensure that dripperline will not work its way to the surface.

3.012 CONTROLLER

A. Mount the controller flush with the mounting surface. Controller should be level with the surface of the floor or concrete mounting pad. Install controller with display at eye-level if at all possible.

B. Mount the controller pedestal with the mounting hardware and template supplied.

C. The automatic controller shall be installed at the approximate location shown on the Drawings (suitable power supply will be supplied as part of other sections and Contract).

D. All local and other applicable codes shall take precedence in connecting the 110-volt electrical service to the controller.

E. Install per local code, manufacturer's latest printed instructions, and as detailed.

F. Valve control wires shall be numbered at the terminal strip.

3.013 CONTROLLER POWER SUPPLY

A. Power to the controller shall be supplied from a dedicated circuit (installed as part of work of other sections and Contract).

B. The Irrigation Contractor shall be responsible for all wiring and associated equipment to connect power supply to the controller.

C. All wiring is to be in accordance with local codes.

3.014 CONTROL WIRING

A. All electrical equipment and wiring shall comply with local and state codes and be installed by those skilled and licensed in the trade.

B. Wiring shall occupy the same trench and shall be installed along the same route as pressure supply or lateral lines whenever possible, and shall have a minimum of twelve inches cover.

C. Control wires shall be installed to the side of the main line whenever possible. Placement over pipes is not permitted.

D. Where more than one wire is placed in a trench, the wiring shall be taped together at intervals of twenty feet.

E. An expansion curl shall be provided within three feet of each wire connection and at least every one hundred feet of wire length on runs of more than one hundred feet in length. Expansion curls shall be formed by wrapping at least five turns of wire around a one-inch diameter pipe, then withdrawing pipe.

F. Control wire splices at remote control valves to be crimped and sealed with specified splicing materials. Line splices will be allowed only on runs of more than five hundred and they must be located in ten-inch round splice boxes that are green in color. The connector shall be 3M DBY splice kit by 3M Corporation, or accepted Substitute. Use one splice per connector sealing pack.

3.015 CLOSING OF PIPE AND FLUSHING OF LINES

A. All testing shall be done under the supervision of the Landscape Architect and Owner. Submit written requests for inspections to the Owner at least three days prior to the anticipated inspection date.
   1. Thoroughly flush out all water lines under a full head of water before installing heads, valves, quick coupler assemblies, etc. Maintain flushing for a minimum of three minutes at the valve located furthest from water supply.
   2. After flushing, cap or plug all openings to prevent entrance of materials that would obstruct the pipe or clog heads. Leave in place until removal is necessary for completion of installation.
   3. Test as specified below.
   4. Upon completion of testing complete assembly and adjust sprinklers for proper distribution.

3.016 TESTING

A. Make hydrostatic when welded PVC joints have cured as per manufacturer's instructions.
   1. Pressurized mainlines:
      a. Completely install water meter, mains, isolation valves and control valves. Do not open laterals.
      b. Open all isolation valves.
      c. Fill all lines with water and shut off at meter.
      d. Test piping at hydraulic pressure of 70 PSIG for one-half hour. Maximum loss shall be five PSI. Locate pump at low point in line and apply pressure gradually.
      e. Install pressure gage shut-off valve and safety blow-off valve between pressure source and piping. Inspect each joint and repair leaks.
      f. Leaks resulting from tests shall be repaired and tests repeated until the system passes.

B. Non-pressurized laterals:
   a. Test piping after laterals are installed and system is fully operational.

3.017 INSPECTIONS

A. The contractor shall maintain proper facilities and provide safe access for inspection to all parts of the work.

B. Irrigation inspection shall consist of a minimum of:
   1. Mainline pressure test.
   2. Coverage test.
   3. Final irrigation inspection.

C. If the specifications, the Owner's and/or Landscape Architect's instructions, laws, ordinances or any public authority require any work to be tested or approved, the contractor shall give the Owner three day's notice of its readiness for inspection.

D. The contractor shall be solely responsible for notifying the Owner and Landscape Architect where and when such work is in readiness or testing.

E. If any work should be covered up without the approval of the Owner and Landscape Architect it must be uncovered, if required, for examination at the contractor's expense.

F. No inspection will commence without "Record" drawings and without completing previously corrections, or without preparing the system for inspection.

3.018 BACKFILLING AND COMPACTING

A. After system is operating and required tests and inspections have been made, backfill excavations and trenches.
   1. Restore all surfaces to match adjacent surfaces. Meet grades flush. Create smooth blends and transitions.

B. Granular fill corresponding with Section Earthwork shall be placed initially on all lines with a minimum of three inches cover. No foreign matter larger than one-half inch in size shall be permitted in the initial backfill.
   1. Backfill in lawns and planting beds shall be planting soils corresponding with the requirements of Section Planting Soil System. Coordinate backfilling of planting soils with the Landscape Contractor. Care should be taken to restore the planting soil profile in accordance with the Contract Documents. Planting soils damaged during trenching shall be discarded. The Landscape Architect shall be the sole judge as to the suitability of the planting soils for reuse.
   2. Surplus subgrade and planting soils remaining after backfilling shall be legally disposed of off-site by the contractor.

3.019 CLEANING AND DISPOSAL OF WASTE MATERIAL

A. Perform clean up during installation of the work and upon completion of the work. Remove from site all excess materials, soil, debris, and equipment as fast as it accumulates.

B. Stockpile, haul from site, and legally dispose of waste materials, including unsuitable excavated materials, rock, trash, and debris.

END OF SECTION 32 84 00

SECTION 32 90 00 - TREES, PLANTS, AND GROUND COVERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of contract, including general and supplementary conditions and Division 1 Specification Sections apply to all work.

B. Refer to Alternates if applicable for this section.

1.02 DESCRIPTION OF WORK:

A. Provide trees, plants, and ground covers as shown and specified. The work includes:

1. Soil preparation and topsoil placement.

2. Procurement and installation of trees, shrubs, and ground covers.

3. Planting mixes.

4. Mulching.

5. Maintenance.

1.03 QUALITY ASSURANCE:

A. Comply with Section 02000 requirements.

B. Plant names indicated comply with "Standardized Plant Names" as adopted by the latest edition of the American Joint Committee of Horticultural Nomenclature. Names of varieties not listed conform generally with names accepted by the nursery trade. Provide stock true to botanical name and legibly tagged.

C. Comply with sizing and grading standards of the latest edition of "American Standard for Nursery Stock". A plant shall be dimensioned as it stands in its natural position.

D. All plants shall be nursery grown under climatic conditions similar to those in the locality of the project for a minimum of 2 years.

E. Stock furnished shall be at least the minimum size indicated. Larger stock is acceptable, at no additional cost, and providing that the larger plants will not be cut back to size indicated. Provide plants indicated by two measurements so that only a maximum of 25% are of the minimum size indicated and 75% are of the maximum size indicated.

F. Provide "specimen" plants with a special height, shape, or character of growth. Tag specimen trees or shrubs at the source of supply. The Landscape Architect will inspect specimen selections at the source of supply for suitability and adaptability to selected location. When specimen plants cannot be purchased locally, provide sufficient photographs of the proposed specimen plants for approval.

G. Plants may be inspected and approved at the place of growth, for compliance with specification requirements for quality, size, and variety.

1. Such approval shall not impair the right of inspection and rejection upon delivery at the site or during the progress of the work.

2. Landscape architect will review plants and will reject any plant, especially trees, for any of the following:
    a. Trees shall not have multiple or co-dominant leaders.
    b. Advantageous roots (roots growing above the root flare)
    c. Root flare of trees set below grade or buried by mulch

H. Provide soil tests. Testing agency shall be acceptable to the Landscape Architect. Provide the following data:

1. Test representative material samples proposed for use. A minimum of (3) three tests shall be done. Contractor to pay for soil tests and amendments recommended in test results.

2. Topsoil:
    a. pH factor.
    b. Mechanical analysis.
    c. Percentage of organic content.
    d. Recommendations on type and quantity of additives required to establish satisfactory pH factor and supply of nutrients to bring nutrients to satisfactory level for planting.

3. Provide test results to owner prior to installation. Provide documentation that amendments recommended in the soil tests were done.

4. Refer to Section 02480. Although specified herein and in Section 02480, topsoil shall be installed and payment made under the Site Preparation contract.

I. Peat Moss:

1. Loss of weight by ignition.
2. Moisture absorption capacity.

1.04 SUBMITTALS:

A. Submit the following material samples:

1. Mulch.

B. Submit the following materials certification:

1. Topsoil source and soil tests.

2. Peat moss.

3. Plant fertilizer.

C. Submit material test reports.

D. Submit all fertilizers, herbicides and insecticides to owner's environmental consultant for verification that products are in compliance with the approved Soil Clean-up Plan and will not adversely affect any future environmental testing on the property.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Deliver fertilizer materials in original, unopened, and undamaged containers showing weight, analysis, and name of manufacturer. Store in a manner as to prevent wetting and deterioration.

B. Take all precautions customary in good trade practice in preparing plants for moving. Workmanship that fails to meet the highest standards will be rejected. Spray deciduous plants in

foliage with an approved "Anti-Desiccant" immediately after digging to prevent dehydration. Dig, pack, transport, and handle plants with care to ensure protection against injury. Inspection certificates required by law shall accompany each shipment invoice or order to stock and on arrival, the certificate shall be filed with the Landscape Architect. Protect all plants from drying out. If plants cannot be planted immediately upon delivery, properly protect them with soil, wet peat moss, or in a manner acceptable to the Landscape Architect. Water heeled-in plantings daily. No plant shall be bound with rope or wire in a manner that could damage or break the branches.

C. Cover plants transported on open vehicles with a protective covering to prevent wind burn.

D. Provide dry, loose topsoil for planting bed mixes. Frozen or muddy topsoil is not acceptable.

E. Plants delivered to the site in non-rottable, 100% natural woven burlap product. Plastic burlap not permitted.

1.06 PROJECT CONDITIONS:

A. Work notification: Notify Landscape Architect at least 7 working days prior to installation of plant material.

B. Protect existing utilities, paving, and other facilities from damage caused by landscaping operations.

C. A complete list of plants, including a schedule of sizes, quantities, and other requirements is shown on the drawings. In the event that quantity discrepancies or material omissions occur in the plant materials list, the planting plan shall govern.

1.07 WARRANTY:

A. Warrant plant material to remain alive and be in healthy, vigorous condition for a period of two (2) full planting seasons or one (1) calendar year from the date of acceptance, for labor and materials after completion and acceptance of entire project.

1. Inspection of plants will be made by the Landscape Architect periodically during installation and at completion of planting.

B. Replace, in accordance with the drawings and specifications, all plants that are dead or, as determined by the Landscape Architect, are in an unhealthy or unsightly condition, and have lost their natural shape due to dead branches, or other causes due to the Contractor's negligence. The cost of such replacement(s) is at Contractor's expense. Warrant all replacement plants for one (1) year after installation and written acceptance by the landscape architect.

C. Warranty shall not include damage or loss of trees, plants, or ground covers caused by fires, floods, freezing rains, lightning storms, or winds over 75 miles per hour, severe drought, winter kill caused by extreme cold and severe winter conditions not typical of planting area; acts of vandalism or negligence on the part of the Owner. It is the contractors responsibility to provide documentation of conditions which, in their opinion, have caused the warranty to be void.

PART 2 PRODUCTS

2.01 MATERIALS:

A. Plants: Provide plants typical of their species or variety; with normal, densely-developed branches and vigorous, fibrous root systems. Provide only sound, healthy, vigorous plants free from defects, disfiguring knots, sun scald injuries, frost-cracks, abrasions of the bark, plant diseases, insect eggs, borers, and all forms of infestation. All plants shall have a fully developed

form without voids and open spaces. Plants held in storage will be rejected if they show signs of growth during storage.

1. Dig balled and burlap plants with firm, natural balls of earth of sufficient diameter and depth to encompass the fibrous and feeding root system necessary for full recovery of the plant. Provide ball sizes complying with the latest edition of the "American Standard for Nursery Stock". Cracked or mushroomed balls are not acceptable.

2. Bare-root plants: Dug with adequate fibrous roots, covered with a uniformly thick coating of mud by being puddled immediately after they are dug, or packed in moist straw or peat moss.

3. Container-grown stock: Grown in a container for sufficient length of time for the root system to have developed to hold its soil together, firm and whole.

4. Provide tree species that mature at heights over 25'-0" with a single main trunk. Trees that have the main trunk forming a "Y" shape are not acceptable.

5. Plants planted in rows shall be matched in form.

6. Plants larger than those specified in the plant list may be used when acceptable to the Landscape Architect.

    a. If the use of larger plants is acceptable, increase the spread of roots or root ball in proportion to the size of the plant.

7. The height of the trees, measured from the crown of the roots to the top of the top branch, shall not be less than the minimum size designated in the plant list.

8. No pruning wounds shall be present with a diameter of more than l" and such wounds must show vigorous bark on all edges.

9. Evergreen trees shall be branched to the ground.

10. Shrubs and small plants shall meet the requirements for spread and height indicated in the plant list.

    a. The measurements for height shall be taken from the ground level to the average height of the top of the plant and not the longest branch.
    b. Single stemmed or thin plants will not be accepted.
    c. Side branches shall be generous, well-twigged, and the plant as a whole well-bushed to the ground.
    d. Plants shall be in a moist, vigorous condition, free from dead wood, bruises, or other root or branch injuries.

2.02 ACCESSORIES:

A. Topsoil for Planting Beds: Fertile, friable, natural topsoil of loamy character, without admixture of subsoil material, obtained from a well-drained arable site, reasonably free from clay, lumps, coarse sands, stones, plants, roots, sticks, and other foreign materials, with acidity range of between pH 6.0 and 6.8.

    1. Identify source location of topsoil proposed for use on the project.

    2. Provide topsoil free of substances harmful to the plants which will be grown in the soil.

B. Peat Moss: Brown to black in color, weed and seed free granulated raw peat or baled peat, containing not more than 9% mineral on a dry basis.

    1. Provide ASTM D2607 sphagnum peat moss with a pH below 6.0 for ericaceous plants.

C. Fertilizer:

1. Plant Fertilizer Type "A": Commercial type approved by the Landscape Architect, containing 12% nitrogen, 12% phosphoric acid, and 12% potash by weight. l/4 of nitrogen in the form of nitrates, l/4 in form of ammonia salt, and l/2 in form of organic nitrogen.

2. Plant Fertilizer Type "B": Approved acid-base fertilizer.

D. Anti-Desiccant: Protective film emulsion providing a protective film over plant surfaces; permeable to permit transpiration. Mixed and applied in accordance with manufacturer's instruction.

E. Mulch: 6 month old well rotted shredded native hardwood bark mulch not larger than 4" in length and l/2" in width, free of woodchips and sawdust.

F. Water: Free of substances harmful to plant growth. Hoses and/or other methods of transportation shall be furnished by the Contractor.

G. Stakes for Staking: Hardwood, 2" x 2" x 8'-0" long.

H. Stakes for Guying: Hardwood, 2" x 2" x 36" long.

I. Guying/Staking Wire: No. 10 or 12 gage galvanized wire.

1. Turnbuckles: Galvanized steel of size and gage required to provide tensile strength equal to that of the wire. Turnbuckle openings shall be at least 3".

J. Staking and Guying Hose: Two-ply, reinforced garden hose not less than 1/2" inside diameter.

K. Tree Wrap: Standard waterproofed tree wrapping paper, 2-1/2" wide, made of 2 layers of crepe kraft paper weighing not less than 30 lbs. per ream, cemented together with asphalt.

L. Twine: Two-ply jute material.

PART 3 EXECUTION

3.01 INSPECTION:

A. Examine proposed planting areas and conditions of installation. Do not start planting work until unsatisfactory conditions are corrected.

3.02 PREPARATION:

A. Time of planting:

1. Evergreen material: Plant evergreen materials between September 1 and November 1 or in spring before new growth begins. If project requirements require planting at other times, plants shall be sprayed with anti-desiccant prior to planting operations.

2. Deciduous material: Plant deciduous materials in a dormant condition. If deciduous trees are planted in-leaf, they shall be sprayed with an anti-desiccant prior to planting operation.

3. Planting times other than those indicated shall be acceptable to the Landscape Architect.

B. Planting shall be performed only by experienced workmen familiar with planting procedures under the supervision of a qualified supervisor.

C. Locate plants as indicated or as approved in the field after staking by the Contractor. If obstructions are encountered that are not shown on the drawings, do not proceed with planting operation until alternate plant locations have been selected.

D. Excavate circular plant pits with gently sloping sides, except for plants specifically indicated to be planted in beds. Provide shrub pits at least 24" greater than the diameter of the root system and 36" greater for trees. All shrubs and trees should be planted a minimum of 6" above surrounding finished grades. Depth of pit shall accommodate the remainder root system. The bottom of the planting pit shall be undisturbed earth or compacted earth. Do not scarify the surface any greater that a depth of 4" to break up hardpan layer. Remove excavated materials from the site.

E. Provide pre-mixed planting mixture for use around the ball and roots of the plants consisting of 4 parts planting topsoil to 1 part moistened peat moss and 1/2 lb. plant fertilizer Type "A" for each cu. yd. of mixture.

F. Provide pre-mixed ground cover or flower bed planting mixture consisting of 4 parts planting topsoil to 1 part peat moss, 1 part mushroom manure, and l/2 lb. plant fertilizer Type "A" per cu. yd.

G. Provide pre-mixed planting mixture for use around the balls and roots of ericaceous plants consisting of 1 part planting topsoil to 1 part spahagnum peat moss and 1/2 lb. plant fertilizer Type "B" per cu. yd. of mixture.

3.03 INSTALLATION:

A. Set plant material in the planting pit to proper grade and alignment. Set plants upright, plumb, and faced to give the best appearance or relationship to each other or adjacent structure. Set plant material 6" above the finish grade. No filling will be permitted around trunks or stems. Backfill around each plant with approved planting mixture. Do not use frozen or muddy mixtures for backfilling. Form a ring of soil around the edge of each planting pit to retain water.

B. After balled and burlap plants are set, muddle planting soil mixture around bases of balls and fill all voids.

1. Remove all burlap, ropes, and wire from the tops of balls and fold down to the bottom of the ball after plant material is set. At least 50% of the vertical surface of the root area should be exposed.

2. All burlap left on root ball when planted shall be 100% natural. If artificial or partially artificial, remove totally from root ball before planting. Notify Landscape Architect as to which plants are in non-natural burlap. Treated burlap is acceptable if product is guaranteed to biodegrade within 12 months of planting. Supply certification.

C. Space ground cover plants in accordance with indicated dimensions. Adjust spacing as necessary to evenly fill planting bed with indicated quantity of plants. Plant to within 6" of the root balls of trees, and shrubs within planting bed and to within 6" of edge of bed.

D. Mulching:

1. Mulch tree plantings (10' minimum diameter in lawn areas), shrub planting pits and shrub beds with required mulching material 2" deep immediately after planting. Thoroughly water mulched areas. After watering, rake mulch to provide a uniform finished surface. Mulch shall not be mounded, shall not cover any bark or root flare of tree.

2. Mulch ground cover or flower beds with mushroom manure mulch 1" to 1-1/2" deep immediately after planting.

E. Wrapping, guying, staking:

1. Inspect trees for injury to trunks, evidence of insect infestation, and improper pruning before wrapping.

2. Wrap trunks of all trees spirally from bottom to top with specified tree wrap and secure in place.
    a. Overlap 1/2 the width of the tree wrap strip and cover the trunk from the ground to the height of the second branch.
    b. Secure tree wrap in place with twine wound spirally downward in opposite direction, tied around the tree in at least 3 places in addition to the top and bottom.

3. STAKING/GUYING:

    a. Stake/guy all trees immediately after lawn seeding or sodding operations and prior to acceptance. When high wind or other conditions which may affect tree survival or appearance occur, the Landscape Architect may require immediate staking/guying.
    b. Stake deciduous trees under 3" caliper. Stake evergreen trees under 8'-0" tall.
    c. Guy deciduous trees over 3" caliper. Guy evergreen trees over 8'-0" tall.

4. All work shall be acceptable to the Landscape Architect.

F. PRUNING:

1. Prune branches of deciduous stock, after planting, to balance the loss of roots and preserve the natural character appropriate to the particular plant requirements. In general, remove l/4 to l/3 of the leaf bearing buds, proportion shall in all cases be acceptable to the Landscape Architect. Revolve or cut back broken, damaged, and unsymmetrical growth of new wood.

2. Multiple leader plants: Preserve the leader which will best promote the symmetry of the plant. Cut branches flush with the trunk or main branch, at a point beyond a lateral shoot or bud a distance of not less than 1/2 the diameter of the supporting branch. Make cut on an angle.

3. Prune evergreens only to remove broken or damaged branches.

3.04 MAINTENANCE:

A. Maintain planting for a period of at least 60 days after completion of planting operations or until all plants are sufficiently recovered from transplanting and in a healthy growing condition acceptable to Landscape Architect. Maintain plantings installed in the fall after September 15 until May 30 of the following year. It is the contractor’s responsibility to maintain all planting until such time as the owner has accepted the entire project, even if acceptance is delayed due to other trades or project elements beyond the scope of landscaping.

B. Maintenance shall include pruning, cultivating, weeding, watering, and application of appropriate insecticide and fungicides necessary to maintain plants free of insects and disease.

1. Re-set settled plants to proper grade and position. Restore planting saucer and adjacent material and remove dead material.

2. Tighten and repair guy wires and stakes as required.

3. Correct defective work as soon as possible after deficiencies become apparent and weather and season permit.

4. Water trees, plants, and ground cover beds immediately after initial planting, and not less than twice per week until final acceptance. Plants must receive a minimum of 1" of water per week. Submit source of water for approval.

3.05 ACCEPTANCE:

A. Inspection to determine acceptance of planted areas will be made by the Landscape Architect, upon Contractor's request. Provide notification at least 10 working days before requested inspection date.

1. Planted areas will be accepted provided all requirements, including maintenance, have been complied with and plant materials are alive an in a healthy, vigorous condition.

B. Upon acceptance, the Owner will assume plant maintenance.

3.06 CLEANING:

A. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, soil, debris, and equipment. Repair damage resulting from planting operations.

END OF SECTION 32 90 00

SECTION 32 91 19 - TOPSOIL

PART 1 GENERAL

1.01 RELATED WORK:

A. Drawings and general provisions of contract, including general and supplementary conditions and Division l Specification Sections apply to all work.

B. Refer to Alternates if applicable for this section.

1.02 DESCRIPTION OF WORK:

A. Perform topsoil placement as shown and specified. The work includes:

1. Site filling to indicated elevations, profiles and contours.

2. Subgrade inspection.

3. Topsoil distribution and finish grading.

1.03 PROJECT CONDITIONS:

A. Known underground and surface utility lines are indicated on the drawings.

B. Protect existing trees, plants, lawns, and other features designated to remain as part of the landscaping work.

C. Promptly repair damage to adjacent facilities caused by topsoil operations. Cost of repair at Contractor's expense.

D. Promptly notify the Landscape Architect of unexpected sub-surface or unacceptable subgrade conditions.

PART 2 PRODUCTS

2.01 MATERIALS:

A. Topsoil: Fertile, friable, natural loamy soil, characteristic of productive soil in the vicinity, reasonably free of subsoil; stones, clay lumps, roots, weeds and other foreign matter greater than 1-1/2" in dimension, or other extraneous or toxic matter harmful to plant growth. Obtain topsoil form naturally, well drained sites where topsoil depth is a minimum of 8"; do not obtain topsoil from marshes, bogs or other wetland sites.

1. Provide imported topsoil materials as required to complete the work. Obtain rights and pay all costs for imported materials.

2. Proposed topsoil material shall be acceptable to the Landscape Architect.

2.02. SUBMITTALS:

A. Submit test report from an approved testing lab for finished topsoil. Contractor to pay for testing.

2.02. SOIL AMENDMENTS:

A. After testing, provide amendments at rates indicated by the soil tests and listed in Section 02490, Trees, Plants, and Groundcovers or in Section 02485, Seeding as required to produce topsoil of optimum performance with pH 6.5.

PART 3 EXECUTION

3.01 PREPARATION:

A. Establish extent of topsoil placement by area and elevation. Set required lines, levels, and elevation.

B. Prior to placement of topsoil, notify Landscape Architect of unacceptable subgrade conditions. Acceptable subgrade requirements are as follows:

1. Rough grading: Plus or minus 0.10 ft. subgrade tolerance. Finish required will be that ordinarily obtained from either blade-grader or scraper operations.

2. Provide subgrade surface free of exposed boulders or stone exceeding 4" in greatest dimension in paved areas; 2" lawn and planting areas.

3. Lawn and planting areas: Allow for 6" average depth of topsoil at lawn areas, and 12" depth at planting areas, except as otherwise indicated on the drawings.

4. Provide 4 inch to 8 inch earth mounding where indicated.

5. Drainage ditches: Grade to profiles indicated.

6. Allow for a minimum pitch of 2% on all surface areas for positive drainage.

7. Allow for a minimum pitch away from buildings of 4% for a minimum of 5' blending to a minimum of 2% to grade brakes as indicated on the drawings.

C. Coordinate extent of contaminated soils with owner’s environmental consultant.

3.02 EXISTING UTILITIES:

A. Before starting topsoil placement, establish the location and extent of underground utilities in the work area. Exercise care to protect existing utilities during topsoil operations. Perform placement of topsoil work near utilities by hand.

B. Maintain, protect, relocate, or extend as required existing utility lines to remain which pass through the work area. Pay costs for this work, except as covered by the applicable utility companies.

3.03 FINISH GRADING:

A. Uniformly distribute and spread stockpiled topsoil. Provide 6" average depth at lawn areas, 12" at planting areas. Provide additional imported topsoil as require to complete the work. Use loose, dry topsoil. Do not use frozen or muddy topsoil. Place during dry weather.

B. Fine grade topsoil eliminating rough and low areas to ensure positive drainage. Maintain levels, profiles, and contours of subgrades.

C. Remove stones, roots, weeds, and debris while spreading topsoil materials. Rake surface clean of stones 1 inch or larger in any dimension and all debris. Provide surfaces suitable for soil preparation provided under lawn and planting work.

D. Maintenance:

1. Protect finish graded areas from traffic and erosion. Keep free of trash and debris. Repair and re-establish grades in settled, eroded, and damaged areas.

2. Where completed areas are disturbed by construction operations or adverse weather, scarify, re-shape, and compact to required density.

3.09 DISPOSAL OF WASTE MATERIALS:

A. Stockpile, haul from site, and legally dispose of waste materials, including excess excavated materials, rock, trash, and debris.

3.10 CLEANING:

A. Upon completion of earthwork operations, clean areas within contract limits, remove tools, and equipment. Provide site clear, clean, free of debris, and suitable for site work operations.

END OF SECTION 32 91 19

SECTION 32 92 19 - SEEDING

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of contract, including general and supplementary conditions and Division 1 Specification Sections apply to all work.

B. Refer to Alternates if applicable for this section.

1.02 DESCRIPTION OF WORK:

A. Provide seeded lawns as shown and specified in the public right-of-way and perimeter disturbed areas. The work includes:

1. Soil preparation and seeding lawns
2. Steep Slope Seed Mix
3. Mulching.
4. Reconditioning existing lawns.
5. Maintenance.

1.03 QUALITY ASSURANCE:

A. Comply with Section 02000 requirements.

B. Provide and pay for materials testing. Testing agency shall be acceptable to the Landscape Architect. Provide the following data:

1. Test representative material samples proposed for use.

2. Topsoil:
    a. pH factor.
    b. Mechanical analysis.
    c. Percentage of organic content.
    d. Recommendations on type and quantity of additives required to establish satisfactory pH factor and supply of nutrients to bring nutrients to satisfactory level for planting.

1.04 SUBMITTALS:

A. Submit seed vendor's certification for required grass seed mixture, indicating percentage by weight, and percentages of purity, germination, and weed seed for each grass species.

B. Submit the following material samples:

1. Seed.

C. Submit the following materials certification:

1. Fertilizer analysis.

C. Submit materials test report.

D. Before applying fertilizer, herbicide or insecticide, submit products to owner’s environmental consultant and verify that usage is appropriate and consistent with the approved Soil Clean-up Plan and will not affect future environmental testing.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Deliver seed and fertilizer materials in original unopened containers, showing weight, analysis, and name of manufacturer. Store in a manner to prevent wetting and deterioration.

1.06 PROJECT CONDITIONS:

A. Work notification: Notify Landscape Architect at least 7 working days prior to start of seeding operation.

B. Protect existing utilities, paving, and other facilities from damage caused by seeding operation.

C. Perform seeding work only after planting and other work affecting ground surface has been completed.

D. Provide hose and lawn watering equipment as required.

1.07 WARRANTY:

A. Provide a uniform stand of grass by watering, mowing, and maintaining seeded areas until final acceptance. Re-seed areas, with specified materials, which fail to provide a uniform stand of grass until all affected areas are accepted by the Landscape Architect.

PART 2 PRODUCTS

2.01 MATERIALS:

A. Lawn seed: Fresh, clean, and new crop seed mixture.

1. Mixed by an approved method.

2. Composed of the following varieties, mixed to the specified proportions by weight and tested to minimum percentages of purity and germination.

B. Blends:

1. Lawn Seed Mix: Refer to Pennsylvania Department of Transportation Specification 408, Section 804 for seed mixture.

Name	*Lbs./Acre*	*Minimum Purity*	*Minimum Germination*
Kentucky Bluegrass *	50	90%	80%
Pennlawn Red Fescue	30	98%	85%
Pennfine Perennial Ryegrass **	20	98%	90%
Streaker Redtop (Agrostis Alba)	1	NA	NA

Submit verification of blend and certification tags to Landscape Architect for approval.

* Minimum of three certified varieties of Bluegrass, no one variety to exceed 40% of mix.
** Minimum of two certified varieties of Ryegrass, no one variety to exceed 40% of mix.

2. Steep Slope Seed Mix: Mix to be ERNMX-181 Native Steep Slope Mix as manufactured by Ernst Seed, 9006 Mercer Pike, Meadville, Pennsylvania, (800) 873-3321. Install 30 lbs. per acre or 1 lbs. per 1000 square feet. Mix shall consist of:

Name	*Common Name*	*% of Mix*
Sorghastrum Nutans	Indiangrass	26%
Lolium Multiflorum	Annual Ryegrass	20%

Schizachyrium Scoparium	Little Bluestem	15%
Elymus Canadensis	Canada Wildrye	12%
Elymus Virginicus	Virginia Wildrye	8%
Panicum Virgatum	Switchgrass	4%
Tridens Flavius	Purpletop	3%
Agrostis Perennans	Autumn Bentgrass	2%
Agrostis Scabra	Ticklebrass	2%
Chamaecrista Fasciculata	Partridge Pea	2%
Rudbeckia Hirta	Blackeyed Susan	2%
Coreopsis Lancelota	Lancleaf Coreopsis	1%
Echinacea Purpurea	Purple Coneflower	1%
Liatris Spicata	Marsh Blazing Star	1%
Mondara Media	Purple Bergamot	1%

C. Straw mulch: Clean oat or wheat straw well seasoned before bailing, free from mature seed-bearing stalks or roots of prohibited or noxious weeds.

D. Water: Free of substance harmful to seed growth. Hoses or other methods of transportation furnished by Contractor.

2.01 SOIL AMENDMENTS:

A. After testing, apply soil amendments at rates recommended by soil test and listed below as required to produce topsoil of optimum performance with a pH of 6.5.

B. Fertilizer:

1. Granular, non-burning product composed of not less than 50% organic slow acting, guaranteed analysis professional fertilizer.

a. Type A: Starter fertilizer containing 5% nitrogen, 10% phosphoric acid, and 5% potash by weight, or similar approved composition mixed into the top 3" of topsoil.

C. Ground limestone: Containing not less than 85% of total carbonates and ground to such fineness that 50% will pass through a 100 mesh sieve and 90% will pass through a 20 mesh sieve.

PART 3 EXECUTION

3.01 INSPECTION:

A. Examine finish surfaces, grades, topsoil quality, and depth. Do not start seeding work until unsatisfactory conditions are corrected.

3.02 PREPARATION:

A. Limit preparation to areas which will be immediately seeded.

B. Finished subgrading work is to be done by others. Landscape Contractor should inspect the site prior to spreading topsoil to insure subgrades are free of ruts, rocks, stones, other debris, and are graded to insure positive drainage. Notify Landscape Architect of any problems that would affect spreading of topsoil.

C. Uniformly distribute and spread stockpiled topsoil. Provide 6" average depth at lawn areas. Use loose, dry topsoil. Do not use frozen or muddy topsoil. Place during dry weather.

D. Fine grade topsoil eliminating rough and low areas to insure positive drainage. Maintain levels, profiles, and contours of subgrades.

E. Remove stones, roots, weeds, and debris while spreading topsoil materials.

1. Fine rake all lawn areas. Rake surfaces clean of stones 1" or larger in any dimension and all debris.

F. Provide surfaces suitable for soil preparation work.

G. Apply limestone, at rate determined by the soil test, to adjust pH of topsoil to an optimum pH 6.5. Distribute evenly by machine and incorporate thoroughly into topsoil.

H. Apply Type A fertilizer to indicated turf areas at a rate equal to 1.0 lb. of actual nitrogen per 1,000 sq. ft. (220 lbs/acre).

I. Apply fertilizers by mechanical rotary or drop type distributor, thoroughly and evenly incorporated with soil to a depth of 3" by discing or other approved method. Fertilize areas inaccessible to power equipment with hand tools and incorporate into soil.

J. Restore prepared areas to specified condition if eroded, settled, or otherwise disturbed after fine grading and prior to seeding.

3.03 INSTALLATION:

A. Seeding operations:

1. Seed immediately after preparation of bed. Spring seeding between Contract commencement or March 15 and June 30, and fall seeding between August 15 but no later than September 30, unless otherwise approved by LaQuatra Bonci Associates.

2. Seed indicated areas within contract limits and areas adjoining contract limits disturbed as a result of construction operation.

3. Perform seeding operation when the soil is dry and when winds do not exceed 5 miles per hour velocity.

4. Apply seed with a rotary or drop type distributor. Install seed evenly by sowing equal quantities in 2 directions, at right angles to each other. If planting after September 30, use of a slit seeder is required.

5. Rates:
    a. Sow grass seed at a rate of 10 lbs per 1,000 sq. ft.

6. After seeding, rake or drag surface of soil lightly to incorporate seed into top 1/8" of soil. Roll with light lawn roller.

B. Mulching:

1. Place straw mulch on seeded areas with 24 hours after seeding.

2. Place straw mulch uniformly in a continuous blanket at the rate of 2-1/2 tons per acre, or 2 50 lb. bales per 1,000 sq. ft. of area.

3. Crimp straw into soil by mechanical means.

C. Watering:

1. Begin watering immediately after planting and until acceptance by the landscape architect and owner.

3.04 MAINTENANCE:

A. Maintain seeded lawns after completion of seeding operations for a period of 60 days. If seeding occurs in the fall after October 15 maintain lawn areas for a period of 60 days commencing on April l the following year.

B. Maintain seeded lawn areas, including watering, spot weeding, mowing, applications of herbicides, fungicides, insecticides, and re-seeding until a full, uniform stand of grass free of weeds, undesirable grass species, disease, and insects is achieved and accepted by the Landscape Architect.

1. Water as required by weather conditions to maintain adequate surface soil moisture for proper seed germination. Continue watering for not less than 30 days applying a minimum of 1" of water per week. Thereafter apply l/2" of water twice weekly.

2. Repair, rework, re-seed, and re-mulch all areas that have washed out, are eroded, or do not catch.

3. Mow lawn areas as soon as lawn top growth reaches a 3" height. Cut back to 2" in height. Repeat mowing as required to maintain specified height during the 60 day guarantee period.

3.05 ACCEPTANCE:

A. Inspection to determine acceptance of seed lawns will be made by the Landscape Architect and Owner, upon Contractor's request. Provide notification at least 10 working days before requested inspection date.

1. Seeded areas will be acceptable provided all requirement, including maintenance, have been complied with, and a healthy, uniform, close stand of the specified grass is established free of weeds, undesirable grass species, disease, and insects.

2. No individual lawn areas shall have bare spots or unacceptable cover totaling more than 2% of the individual areas, in areas requested to be inspected.

B. Upon acceptance, the Owner will assume lawn maintenance.

3.06 CLEANING:

A. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, debris, and equipment. Repair damage resulting from seeding operations.

END OF SECTION 32 92 19

SECTION 330500 - COMMON WORK RESULTS FOR UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Piping joining materials.
2. Transition fittings.
3. Grout.
4. Flowable fill.
5. Piped utility demolition.
6. Piping system common requirements.

1.3 DEFINITIONS

A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.

B. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

C. ABS: Acrylonitrile-butadiene-styrene plastic.

D. CPVC: Chlorinated polyvinyl chloride plastic.

E. HDPE: High Density Polyethylene plastic.

F. SLCPP: Smooth Lined Corrugated plastic.

G. PVC: Polyvinyl chloride plastic.

1.4 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.

PART 2 - PRODUCTS

2.1 PIPING JOINING MATERIALS

A. 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.

2.2 TRANSITION FITTINGS

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

B. Transition Couplings NPS 1-1/2 (DN 40) and Smaller:

1. Underground Piping: Manufactured piping coupling or specified piping system fitting.

C. AWWA Transition Couplings NPS 2 (DN 50) and Larger:

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. Cascade Waterworks Mfg. Co.
b. Dresser, Inc.; DMD Div.
c. Ford Meter Box Company, Inc. (The); Pipe Products Div.
d. JCM Industries.
e. Smith-Blair, Inc.
f. Viking Johnson.
g. Approved equal.

2. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.

D. Plastic-to-Metal Transition Fittings:

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. Spears Manufacturing Co.
b. Approved equal.

2. Description: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

E. Plastic-to-Metal Transition Unions:

1. 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. Colonial Engineering, Inc.
    b. NIBCO INC.
    c. Spears Manufacturing Co.
    d. Approved equal.

F. Flexible Transition Couplings for Underground Non-pressure Drainage Piping:

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. Cascade Waterworks Mfg. Co.
    b. Fernco, Inc.
    c. Mission Rubber Company.
    d. Plastic Oddities.
    e. Approved equal.

2. Description: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, stainless steel shear ring and 316 series stainless steel nut and bolt clamps. Coupling to be Fernco 5000 Series (or approved equal).

2.3 GROUT

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

1. Characteristics: Post hardening, volume adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5,000 psi 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.4 FLOWABLE FILL

A. Description: Low-strength-concrete, flowable-slurry mix.

1. Cement: ASTM C 150, Type I, portland.
2. Density: 115- to 145-lb/cu. ft.
3. Aggregates: ASTM C 33, natural sand, fine and crushed gravel or stone, coarse.
4. Aggregates: ASTM C 33, natural sand, fine.
5. Admixture: ASTM C 618, fly-ash mineral.
6. Water: Comply with ASTM C 94/C 94M.
7. Strength: 100 to 200 psig at 28 days.

PART 3 - EXECUTION

3.1 PIPED UTILITY DEMOLITION

A. Refer to Section 311000 "Site Clearing" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping. Fill abandoned piping with flowable fill, and cap or plug piping with same or compatible piping material.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING INSTALLATION

A. Install piping according to the following requirements and utilities Sections specifying piping systems.

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

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

D. Install piping to permit valve servicing.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

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

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

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and utilities Sections specifying piping systems.

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

C. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Non-pressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Non-pressure Transition Fittings: Join according to ASTM D 3138 Appendix.

D. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

E. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.

F. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

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

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Install dielectric fittings at connections of dissimilar metal pipes.

END OF SECTION 330500

SECTION 334200 – STORMWATER CONVEYANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes storm drainage outside structures, including but not limited to, the following components:

1. Drains and piping.
2. Storm inlets, catch basins, yard inlets, manholes, and inline traps.

1.3 DEFINITIONS

A. SLCPP: Smooth Lined Corrugated Plastic Pipe.

B. PVC: Polyvinyl Chloride Pipe.

C. CMP: Corrugated Metal Pipe.

D. PWSA: Pittsburgh Water and Sewer Authority.

E. ACHD: Allegheny County Health Department.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Pipe and fittings
2. Manhole, catch basin and storm inlet frames, covers and/or grates
3. Manholes, Stormceptors, inlets, yard drains and inline drains.

B. Shop Drawings: Three (3) copies of the following shall be submitted for approval prior to ordering material:

1. Storm inlets: concrete design mix, 4000 psi, 28 day compressive strength as well as the certification from the manufacturer that the structure will support the design load.
2. Storm manholes: see above for concrete requirements.
3. Storm sewer frames and grates.

C. Submit to Engineer prior to ordering material. Submit to PWSA and/or ACHD as required.

D. Field quality testing reports.

1. Backfill: Compaction test reports.

1.5 DELIVERY, STORAGE, AND HANDLING

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

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

C. Handle manholes, catch basins and storm inlets according to manufacturer's written rigging instructions to prevent damage to the structures.

1.6 PROJECT CONDITIONS

A. Interruption of existing storm drainage service: do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than two (2) working days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Owner’s written permission.

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. 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.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Installation" article for applications of pipe, fitting, and joining materials.

2.3 CONCRETE

A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

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

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A, Grade 60, deformed steel.
3. All wire fabric and reinforcement bars shall be free of scale, oil, ice and structural defects and shall be stored to prevent contact with the ground.

C. Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to one-half of pipe diameter. Form curved channels with smooth, uniform radius and a minimum of two (2%) percent slope through the manhole and/or inlet.
2. Benches: Concrete, sloped to drain into channel at a minimum of four (4%) percent.

2.4 MORTAR

A. General: Shall be composed of one (1) part Portland cement and two (2) parts sand by volume. Hydrated lime, not to exceed four (4) pounds of lime to each bag of cement, may be added if approved by the Engineer. Material requirements shall be as follows:

1. Portland Cement: shall conform to the requirements of AASHTO Designation M-85, Type II.
2. Hydrated Lime: shall conform to the requirements of ASTM C-6.
3. Mortar Sand: shall conform to the requirements of AASHTO M-45, except the aggregate shall be no coarser than #8 sieve size.
4. Water: shall be clean and contain no foreign matter such as oil, vegetation, acid, salts organic matter, etc. The water shall be from a municipal water system.

B. Mortar shall be mixed in a machine mixer, except when the amount of mortar to be used makes it undesirable. If hand mixing is used, the dry ingredients must be mixed thoroughly in a box prior to adding the proper quantity of clean water. The water shall be gradually added and then the materials shall be hoed or worked until a uniform mixture is prepared. No mortar shall be re-tempered and none shall be used more the one and on-half (1 1/2) hours after initially mixed. All excess mortar must be discarded after each day of work has been completed.

2.5 LADDER RUNGS

A. Ladder rungs shall be made of polypropylene meeting the requirements of ASTM D-4101 surrounding a one-half (1/2”) inch grade 60 deformed reinforcing bar meeting ASTM A-615 requirements. A 1- ½” x ½” reflector is to be installed at both ends of the ladder rung. Tread width shall be fourteen (14”) inches or wider.

2.6 MANHOLES

A. Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints. The concrete shall have a minimum compressive strength of four thousand (4,000) psi.

1. Inside Diameter: As indicated on the Drawings. No additional compensation will be considered for “upsizing” any manhole if required.
2. Ballast and Base Section: Construct as shown on the Construction Detail. The base, ballast and floor sections shall be monolithically poured in accordance with ASTM C 478.
3. Joints: Shall be tongue and groove type formed in such a manner so that the joint sealant material can be applied evenly. A double strip of sealant is required at each joint.
4. Benched Inverts: Benched inverts shall be either monolithically poured with the base either in the factory or poured on site after the manhole and pipes have been installed.
5. Riser Sections: Five (5”) inch minimum wall thickness for 48” diameter manholes with lengths varying to obtain proper depth. Eight (8”) inch minimum wall thickness for 84” diameter manholes with lengths varying to obtain proper depth. Nine (9”) inch minimum wall thickness for 96” diameter manholes with lengths varying to obtain proper depth.
6. Top Section: Construct as shown on the construction detail. Top of cone of size that matches grade rings. The top of cone or top section shall be cast with insert holes to receive the anchor bolts shown on the construction detail.
7. Transition Section: As required. Indicate location of each transition section per individual structure on manufacturer’s submittal.
8. Joint Sealant: ASTM C 990 butyl rubber, two (2) strips per joint.
9. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
10. Ladder Rungs: Construct as shown on the construction detail.
11. Grade Rings: Reinforced-concrete rings up to twelve (12) inches in height, brick and mortar up to six (6) inches in height or steel rings six (6) to twelve (12) inches in height. The grade rings/brick shall match the diameter and thickness of the manhole frame and cover. All concrete/steel grade rings shall be designed with anchor bolts matching the location of the holes in the frame.
12. Manhole Frames and Covers: Install as shown on the construction detail. All frames and covers shall fit together in a satisfactory manner to prevent rocking, rattling or shifting in traffic. The frame shall be designed with anchor bolts matching the location of the holes in the top section of the manhole. All frames and covers shall be grey cast iron and meet the specifications set forth in the latest revisions of AASHTO M-105, Class 30. The cover shall include the word “STORM” stamped or cast into the cover a minimum of two (2”) inches in height.
13. Identification: All structures shall have the identification number and manufacturer’s name stamped on each section.

2.7 IMPERMEABLE LINER

A. Impermeable liners shall be Layfield Enviro Liner 6040 (or approved equal) LLDPE polyethylene liner with factory fabricated seams. Field installation shall be according to the manufacturer’s written instructions with manufacturer field supervision as required.

2.8 STORM INLETS

A. Standard Precast Concrete Storm Inlets: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.

1. Base Section: Six (6")-inch minimum thickness for integral floor slab and walls constructed as shown on the Construction Detail.
2. Riser Sections: Six (6")-inch minimum thickness and heights to provide depth indicated.
3. Joint Sealant: ASTM C 990 butyl rubber.
4. Pipe Entrance Holes: Inlet boxes shall be precast with holes sized to accept the proposed pipe at the angles shown on the Plans. Pipes shall be encased in mortar on both the inside and outside of the storm inlet wall to ensure a tight seal. The inside wall of the inlet shall have a smooth finish. "Knockout" type inlet boxes will not be acceptable.
5. Ladder Rungs: Install ladder rungs in inlets greater than four (4) feet in depth as measured from the floor slab to the grate.
6. Storm Inlet Frames and Grates: Supply and install as shown on the Construction Detail. All frames and grates shall be grey cast iron and meet specifications set forth in the latest revisions of AASHTO M-105, Class 30, unless otherwise indicated.
7. Sewer Brick for Adjustments: All sewer brick shall meet the specifications set forth in the latest revision of AASHTO Designation M-91, Grade SS.
8. Weep Holes: Insert one (1') inch diameter PVC pipe or drill one (1") inch diameter holes into the wall. Upsize holes if required by the Construction Detail.
9. Curb Drains: Insert holes as shown on the Construction Detail.
10. Sizing: Provide inlets as indicated on the Drawings. No additional compensation will be considered for "upsizing" any inlet.

B. Inlets shall be constructed in accordance with the Construction Detail shown on the Plans. In lieu of pre-cast inlets, poured-in-place inlets may be used upon written approval of the Owner and/or Engineer.

2.9 YARD DRAINS

A. Yard drains: Supply and install per the Construction Detail.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. General Locations and Arrangements: Install all drainage structures and pipe in the locations shown on the Drawings and/or as directed by the Owner and/or Engineer. Pipe shall be of the type and size specified and shall be laid accurately to line and grade. Structures shall be accurately located and properly oriented. Pipe shall be laid upgrade unless otherwise approved by the Engineer. The Contractor shall use laser beam equipment to control the grade of the trench bottom as well as for pipe grade.

B. Where specific installation specifications are not indicated, follow piping manufacturer's written instructions, unless otherwise indicated

C. Bell and spigot pipe shall be laid with the bell end upgrade; tongue and groove pipe shall be laid with the groove end upgrade. The pipe shall be jointed so that there will be uniform space around the pipe. Trimming of the pipe shall not be allowed.

D. The installation of all drainage structures and pipe within the public rights-of-way and/or easements shall conform to the requirements of the agency having jurisdiction.

E. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

F. Pipe installation, extension or repair: Install the same type and size of pipe unless otherwise directed by the Engineer. Connect existing to new as directed by the Engineer, according to manufacturer's recommendations or as directed by authority having jurisdiction.

G. Install catch basins, storm inlets and/or drains at changes in direction and slope.

H. Install manufactured service connections as required or directed.

I. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or a combination of both.

J. Install gravity-flow, non-pressure drainage piping according to the following:

1. Install piping with a minimum cover of three (3') feet, unless otherwise indicated.
2. Install polyethylene corrugated sewer piping according to CPPA's "Recommended Installation Practices for Corrugated Polyethylene Pipe and Fittings."

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

L. All pipes entering structures shall be cut flush with the inside face of the structure, unless otherwise specified by the Engineer. The cut ends of the pipe and the surface of the structure shall be properly rounded and finished so that there will be no protrusion, ragged edges or imperfections that will impede the flow of water or affect the hydraulic characteristics of the installation. (Pipe sections shall be cut to size before setting in the trench). Reinforcing shall not be left exposed in a cut section of reinforced concrete pipe. Only full sections of pipe shall be used where entering a structure which will be exposed to view, such as endwalls, headwalls, end sections, etc.

M. The Contractor shall protect the installation at all times during construction. Movement of construction equipment, vehicles and loads over and adjacent to any pipe shall be performed at the Contractor's risk. At all times when pipe laying is not in progress, all open ends of pipes shall be closed by approved temporary water tight plugs. If water is in the trench when work is resumed, the plug shall not be removed until the trench has been pumped dry and all danger of water entering the pipe has passed.

N. The Contractor may need to adjust the line and grade of the new storm sewer in order to avoid conflicts with utility service lines. Such adjustments shall be made in advance of new storm sewer installation and at no additional cost to the Owner.

O. The Contractor may be required to remove and replace existing storm sewer to install new storm sewer pipe at no additional cost to the Owner.

P. The pipe shall be laid on a six (6")-inch bed of AASHTO #57 limestone and backfilled in the pipe zone as listed elsewhere in these Specifications.

Q. The storm sewer pipe shall be backfilled above the pipe zone as required per the applicable critical or non-critical trench requirements.

R. The Contractor shall excavate and locate any utilities that may exist so that adjustments may be made to the storm sewers if necessary to avoid conflicts. In the event of a conflict, the Owner and/or Engineer shall be notified immediately for instructions on how to proceed.

S. “SLCPP” shall be ADS N-12 WT IB (or approved equal) pipe meeting AASHTO M252, Type S for four (4”)-inch through ten (10”)-inch and AASHTO M294, Type S or ASTM F 2306 for twelve (12”)-inch through sixty (60”)-inch.

T. “CMP” shall be 14 gauge, Type 2 aluminized steel pipe with hugger bands and gaskets.

3.2 PIPE JOINT CONSTRUCTION

A. Basic pipe joint construction shall follow piping manufacturer's written instructions.

B. Join gravity-flow, non-pressure drainage piping according to the following:

1. Join SLCPP according to ADS, Inc. Drainage Handbook (or approved equal).
2. Join PVC according to ASTM D 2774, ASTM F 1668, ASTM D 2321 and manufacturer’s published guidelines.
3. Join CMP according to National Corrugated Steel Pipe Association (NCSPA) Installation Manual and manufacturer’s published guidelines.

3.3 STORM DRAINAGE STRUCTURE INSTALLATION GENERAL REQUIREMENTS

A. Install storm drainage structures complete with appurtenances and accessories in the location and to the depth shown on the Plans and Profiles. Install all storm drainage structures as shown on the Construction Detail.

B. No concrete or masonry shall be laid when the temperature is below forty (40) degrees Fahrenheit, or when indications are for lower temperatures within twenty-four (24) hours, unless protection of concrete and masonry is provided. In this event, the Contractor shall take such measures to prevent concrete and masonry from being exposed to freezing temperatures for a period of not less than five (5) days after installation. Any damage to the structure because of freezing shall be corrected by the Contractor at his own expense.

C. Storm drainage structures are to be constructed as soon as the pipe laying reaches the location of the structure. Should the Contractor continue his pipe laying without making provision for completion of the storm drainage structure, the Engineer shall have the authority to stop the pipe laying operations until the structure is completed.

D. In constructing storm drainage structures the Contractor shall accurately locate each structure and set accurate templates to conform to the required line and grade. Any storm drainage structure which is mislocated or oriented improperly shall be removed and rebuilt in its proper location, alignment and orientation at the Contractor's sole cost and expense.

E. All storm drainage structures located in or adjacent to a pavement subgrade shall be provided with weep holes at appropriate elevations to completely drain the subgrade.

F. All storm drainage structures shall be placed on foundations constructed of a minimum of six (6") depth AASHTO #57 approved limestone.

G. Masonry: All brick or concrete block shall be thoroughly wetted before laying. All masonry shall be laid in a full bed of mortar, and all vertical and horizontal joints shall be filled solid with mortar. Vertical joints on each succeeding course shall be staggered. Joints shall be not less than three eighth (3/8")-inch or more than one half (1/2")-inch wide. Joints on the inside of the structure shall be neatly struck and pointed. The exterior surface of the masonry walls shall be plastered with a one-half (1/2") inch coat of 1:2 cement mortar.

H. Inverts: Smooth concrete invert channels shall be constructed in all storm drainage structures with a true semi-circle channel to insure a smooth flow of water through the structure. Half pipe and fittings shall be used in the pipe invert, wherever practical. The invert channels shall be carried up to the elevations shown on the Contract Drawings. Channels shall slope smoothly and evenly from the entrance pipes to the outlet pipe for storm drainage structure that do not have sumps. Bottom of structures shall be poured to provide positive drainage and continuous concrete channels. Structures with sumps will not be required to have inverts and/or benches

I. Frames, Covers and/or Grates: Frames, Covers and/or Grates storm drainage structure shall be of the type and size indicated on the Drawings. Frames shall be bedded in mortar a minimum of one (1") inch thick, anchored with three quarter (3/4") inch bolts, and shall be set accurately to the correct alignment and grade. In areas to be paved, frames shall be set by using four (4) points of reference, set ninety (90) degrees apart, to insure accurate setting to proposed pavement grade. Covers and grates shall be installed properly to eliminate the potential of rocking in the frame.

J. Ladder Rungs: Ladder rungs shall be installed in all storm drainage structures unless otherwise specified. Ladder rungs shall be installed in all storm drainage structures, spaced twelve (12) inches on center vertically. The maximum distance from the top of the manhole casting to the first step shall be no greater than eighteen (18) inches.

K. Set tops of frames and covers flush with finished surface, unless otherwise specified by the Owner and/or Engineer.

L. Storm inlet and catch basin frames and covers in pavement areas shall be set one half (1/2") inch lower than the final surface elevation, unless otherwise indicated.

M. Pre-cast storm drainage structures shall be installed only after Shop Drawings have been approved by the Engineer.

N. The top grade of the pre-cast concrete manhole corbel and catch basin/storm inlet section shall be set at grade or sufficiently below finished grade to permit a maximum of two (2) courses of brick to be used as risers to adjust the grade of casting. Manhole, catch basin and storm inlet frames shall be set on a grout pad as specified.

O. Pre-cast concrete grade rings may be used between the top section and the structure's frame to meet existing grades up to twelve (12") inches. All grade rings shall have holes in them to allow for the casting to be connected to the last concrete section with three quarter of an inch (3/4") diameter bolts. The holes around the bolts shall be grouted after installation with non-shrink grout.

P. Steps shall be installed during the casting of the structure and aligned in accordance with the Construction Detail.

Q. Inlets and manholes shall be constructed in accordance with the Construction Details. In lieu of pre-cast inlets, poured-in-place inlets may be used. If poured in place inlets are used, the Contractor will be required to place forms on the outside of the inlet, and “wild” pours will not be permitted. Poured-in-place inlets shall have a minimum wall and base thickness of eight (8”) inches and will be reinforced with #4 rebar twelve (12”) inches center to center, both ways. All inlets over five (5’) feet in depth, measured from the top of grate to downstream invert, shall have steps installed, per the Construction Detail. All backfill around the inlets shall be compacted PennDOT 2A approved limestone.

R. Inlets shall have cast iron frames and castings as shown on the Construction Detail.

S. All inlets shall have a PennDOT approved bicycle safe grate supplied by a manufacturer listed on PennDOT Bulletin 15.

T. All manholes and inlets shall have concrete inverts poured to direct the flow of water and to aid in self-cleaning.

U. Place cast-in-place concrete according to ACI 318/318R.

3.4 CONNECTIONS TO EXISTING FACILITIES

A. The Contractor shall make all required connections of the proposed drainage facilities into existing drainage facilities, where and as shown on the Drawings, including implementing modifications to the storm water management and erosion control facilities on the site.

B. Connections made into existing drainage facilities shall be performed in accordance with the requirements of the Facility Owner. The cost of making connections shall be included in the bid price for the pipe or structure.

3.5 CLEANING

A. The Contractor will be required to clean the entire drainage system of all debris and obstructions. This shall include, but not be limited to, removal of all formwork from structures, concrete and mortar droppings, construction debris and dirt. The system shall be thoroughly flushed clean. The Contractor shall furnish all necessary water, hoses, pumps, pipe and other equipment that may be required for this purpose. No debris shall be flushed into existing storm drains or streams. All debris shall be gathered and promptly removed from the site. Payment for this requirement shall be incidental to the bid price for pipe.

3.6 TESTING AND REPAIR

A. Closed Circuit Television (CCTV) – Closed circuit television inspection may be required at the Owner and/ or Engineer’s direction or if listed as a requirement elsewhere in the Specifications. CCTV inspections shall follow applicable Specification Sections or industry-accepted standards. Defects discovered as a result of CCTV inspection (or by any other means) shall be repaired at the Contractor’s sole cost and expense to the Engineer’s complete satisfaction.

3.7 FINAL INSPECTION REQUIREMENTS

A. Upon completion of the Work and before final acceptance by the Owner, the entire drainage system shall be subject to a final inspection in the presence of the Owner and/or Engineer. The Work shall not be considered as complete until all requirements for line, grade, cleanliness, and workmanship have been completed to the satisfaction of the Owner and/or the Engineer.

B. The installed system may be subject to close circuit television (CCTV) inspection prior to release of the posted Maintenance Bond. The Contractor shall acknowledge this requirement during the bidding process.

END OF SECTION 334200